CHAPTER 6

Utility Patent Drawings

This chapter details the specific requirements of formal utility patent drawings; refer to Chapter 5 for a discussion of formal and informal drawings. Also refer to Chapter 5 and *Patent It Yourself*, our companion volume, for additional details on utility patents, including the types of inventions that qualify for them and how to prepare the written portion of the patent application.

It is very important to plan the drawings carefully before starting to draw, such as the number of views from different angles, the specific angle of each view, whether to use sectional or exploded views, and how to show the movement of movable parts. The more complicated the invention, the more planning is necessary. There are many issues that must be worked out first. This chapter will help you accomplish that. Therefore, you should understand this chapter before planning the drawings.

Amount of Detail Required

The two most important requirements regarding utility patent drawings are:

- The drawings and the written description (collectively known as the "disclosure") must be detailed and clear enough to enable a person skilled in the pertinent field to make and use your invention. That is, the disclosure must be "enabling." For example, if your invention is a medical laser, your drawings and description must be detailed enough to show a medical laser engineer how to make and use your invention. While your drawings do not have to be detailed enough for everyone to understand the invention, you should try to make them understandable to a layperson since your examiner (and any judge who may subsequently rule on your patent) may not have a technical background in the field of your invention.
- The drawings must show all the parts or elements mentioned in the specification, including the description of the invention (technical description) and claims (legal description). For example, if the description and claims mention Parts A, B, and C, the drawings must show all three parts.

Some Details May Be Left Out

Satisfying the above requirements doesn't mean that the drawings must show every tiny detail. As mentioned, they have to show only enough to enable "a person skilled in the pertinent field to make and use your invention." Therefore, details that such a skilled person would know to provide may be left out. Generally, implicitly required elements, such as screws that attach parts together, need not be shown or described. If your invention is electromechanical (a mechanical device with electrical parts), you do not have to show the wires if you provide a separate electrical diagram. Some conventional elements may be illustrated with symbolic representations if their detailed illustration is not essential for an understanding of the invention. For example, if a conventional, off-the-shelf steam generator is used in a new steam cleaner, the steam generator may be simply represented by a box labeled "Steam Generator."

Also, a conventional element may be mentioned in the description but not shown in the drawings if it is not essential for an understanding of the invention. Such an element should be followed by the note "(not shown)."

EXAMPLE 1:

The invention in Illustration 6.1 includes an electrically driven roller 23 that drives a belt 21r around passive rollers 5 and 6. Instead of showing a detailed drawing of a motor connected to the driven roller, a circle is used to represent it. A simple electrical circuit (the lines and symbols connected to the right of roller 23) shows that the roller is electrically driven by a battery, which need not be numbered or mentioned in the description because it is readily understood by anyone skilled in the field. Note that the rollers are not shown to be connected to any supporting structure, which is acceptable as long as this fact is mentioned in the description. For example, you may write, "The elements shown in Fig. 1 are mounted in a suitable housing and the rollers are journaled in suitable bearings (not shown)," because the housing will also be readily apparent to anyone skilled in the field.

EXAMPLE 2:

The motor vehicle gear position indicator in Illustration 6.2 includes a housing 10 positioned above a steering column 12. Housing 10 need not be shown mounted to any supporting structure, if such structure is conventional, and the description mentions such structure. For example, "Housing 10 is mounted in a conventional instrument panel (not shown)."

Better to Include Too Much Rather Than Too Little Detail

There is no precise way to determine exactly how detailed the drawing must be. When in doubt, you should err on the side of providing more detail, because while too much detail would not hurt, too little detail definitely will since the PTO will not allow you to add any new technical matter to the disclosure after your application is filed.

Dimensioning Is Usually Unnecessary

Do not include the dimensions or angles of the parts in the drawing unless they are crucial to the understanding of the invention, or if they are important in distinguishing your invention from the prior art (similar but older devices). However, if you do include dimensions or angles, the PTO prefers metric units (millimeters, centimeters, and meters) over English units (inches and feet). If you prefer to include English units, you should use both metric and English—for example, "level 5 is 10 cm (2.5 inches) long."

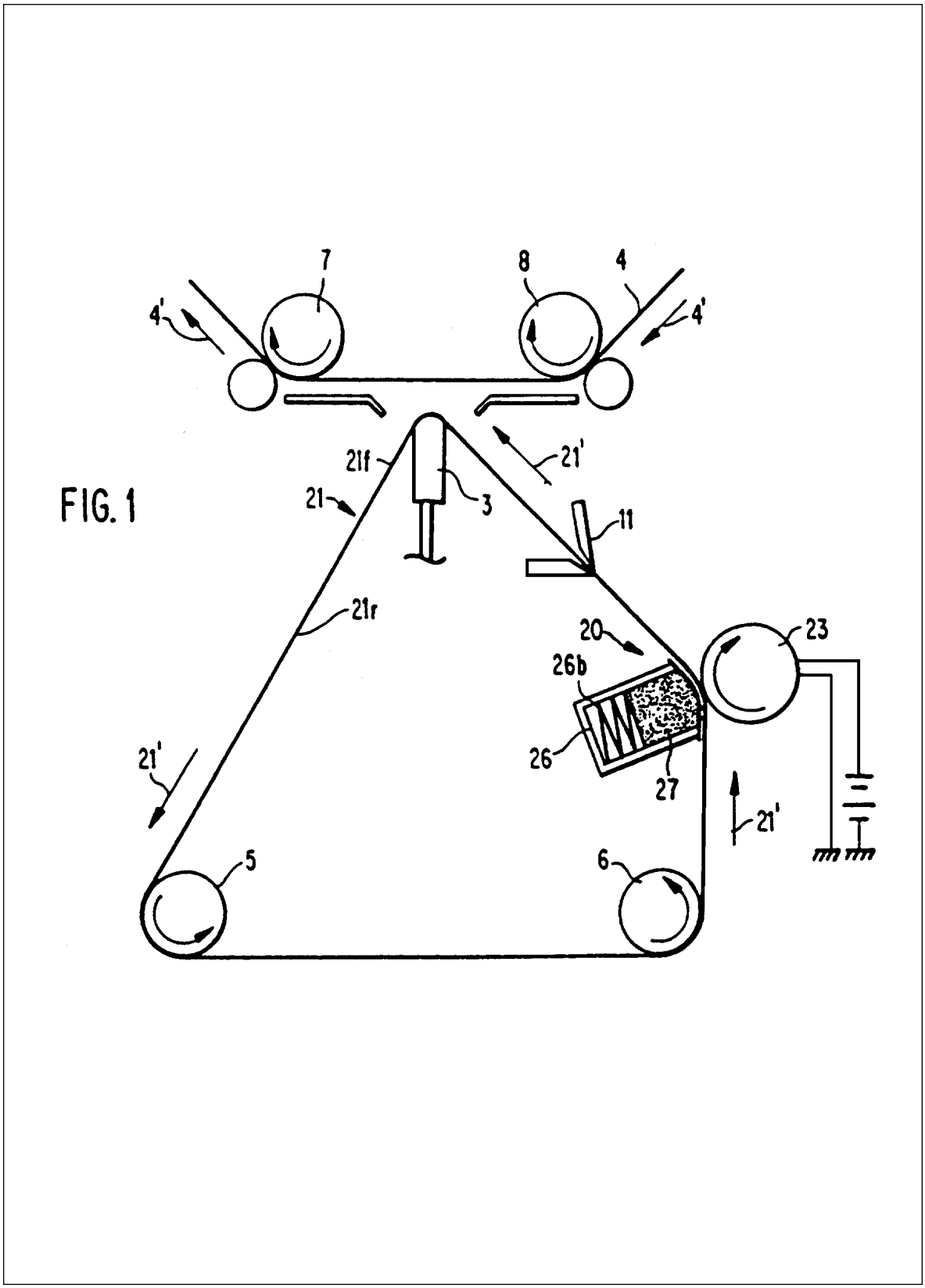


Illustration 6.1—Leaving Out Some Detail

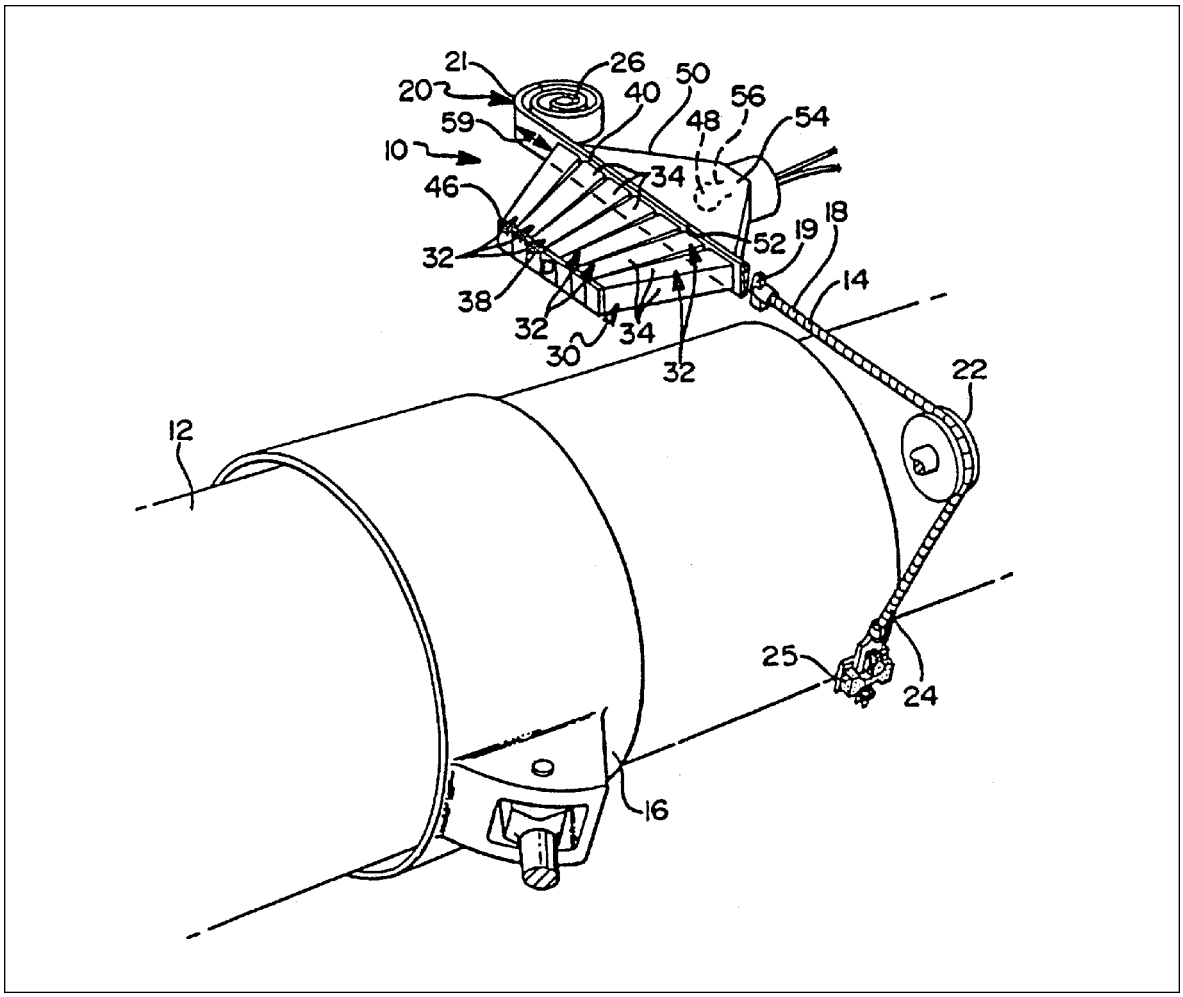


Illustration 6.2—Leaving Out Some Detail

Idealized Parts

You can apply for a patent even if you have not made a model. If you have a rough model or prototype of your invention, you do not have to show an exact representation of it in the drawings; you can show it in an idealized form if you wish. For example, if the model has a part that was fabricated by attaching two or more elements together, it can be shown as a single, integral part, such as in Illustration 6.3. Joints between parts that are not meant to be separable—that is, they are permanently connected—can be left out. Also, a detail can be eliminated if it is not necessary for a complete understanding of an invention, and you do not care to claim it.

EXAMPLE:

You invented a portable table with a new folding mechanism. When you built your prototype, you used a height-adjustable leg that you happened to find in your workshop. You can show the leg in a simplified, nonadjustable form, if:

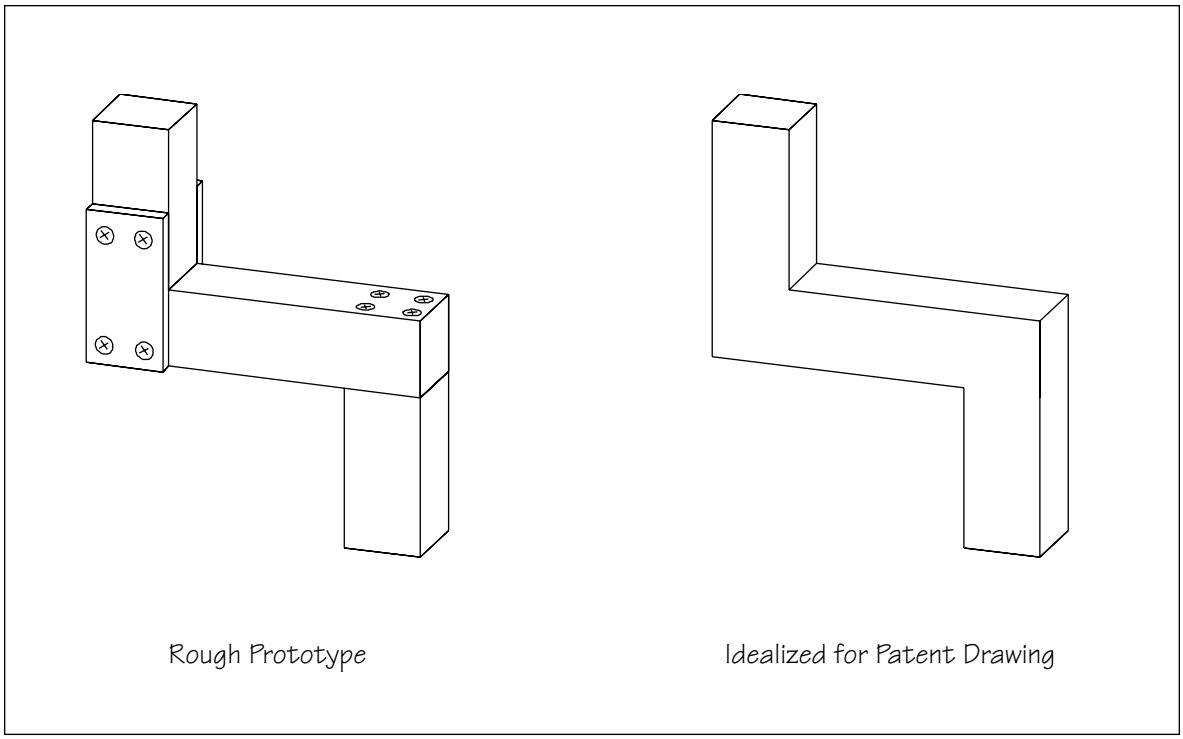


Illustration 6.3—Idealized Parts

- You feel that the adjustability of the leg is not an important part of your invention.
- You do not describe the leg as being adjustable in the description.
- You do not recite the leg as being adjustable in the claims.

Invention Part of Larger Machine

An invention that forms part of a larger conventional machine, such as a transmission for a motor vehicle, can be shown with just a small portion of the larger machine to illustrate its role. Illustration 6.4 shows a transmission controller that includes a control box 30 and an actuator 28. The dashboard is partially presented to show where the control box is installed, and a "disembodied" transmission 16 is presented to show where the actuator is attached. Such a drawing is perfectly acceptable.

Number All Parts

All parts or elements in a utility patent drawing mentioned in the description and claims must be designated with reference numerals or characters. See Chapter 8 for details on reference numerals.

Make as Many Drawings as Necessary

Most inventions cannot be clearly understood with one figure. You must make as many figures as necessary, so that the structure and operation of your invention may be easily understood. Later in this chapter, we detail the different types of figures or views that may be used.

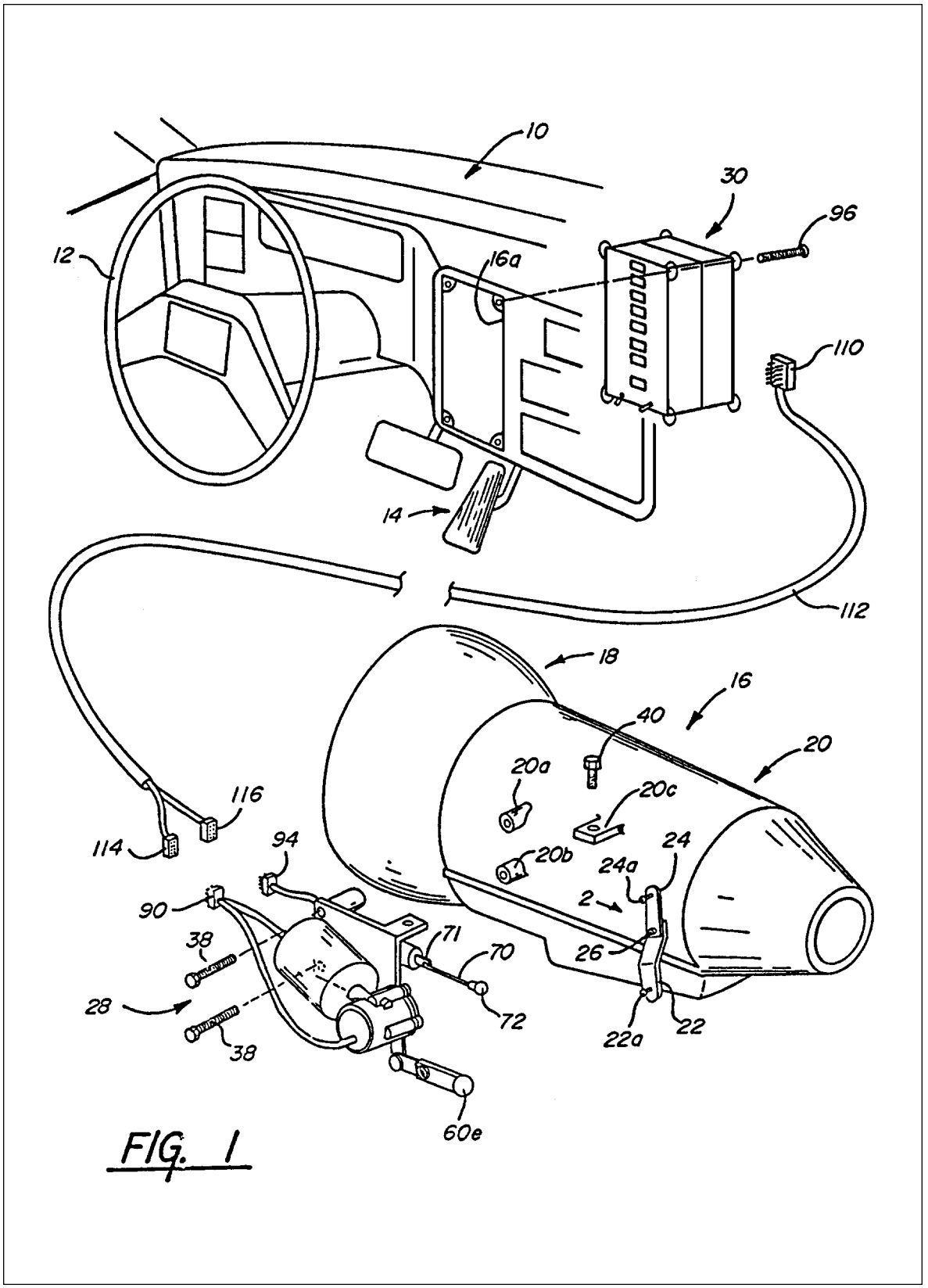


Illustration 6.4—Invention Part of Larger Machine

No Changes Are Permitted After Filing

As stated, no "new matter"—that is, technical information not shown or described in the original drawings or description—can be added after the application is filed. For example, the drawings cannot be changed to incorporate substitute parts, new features, or improvements. Therefore, submitting a drawing that does not clearly illustrate the invention is an error that cannot be fixed, because new parts would have to be added to the drawing to improve understandability. Such parts will most likely be considered to be new matter and, therefore, will not be accepted by the PTO.

The determination of whether a drawing adequately conveys an invention is made when the application is first seen by an examiner. This usually happens many months to over a year after the filing date. (See Chapter 13 of *Patent It Yourself*.) If the application is rejected because the drawings are not clear enough, the only ways to overcome the objection are to try to convince the examiner to reverse position (a difficult task) or to change the drawings and file them with a second application, known as a continuation-in-part application (CIP), which requires a new filing fee. (See Chapter 9 for details on how to overcome rejections.) The new matter filed with a CIP will not get the benefit of the original filing date. (See Chapter 14 of *Patent It Yourself* for more information on CIPs.) Therefore, the drawing is just as important to the whole application as the written portion and must be clear and adequately detailed.

How to Check for Adequacy

Having created an invention, the inventor is so familiar with it that he or she sometimes takes its structure and operation for granted and omits small but vital details in the drawing. One way to avoid falling into this trap is to show the drawing and description in confidence to others (preferably those who are skilled in the same field) and ask them if your documents are clearly understandable. At the very least, carefully consider if they are understandable to someone skilled in the field, but who has never seen your invention before.

Types of Views

A complete understanding of an invention often requires multiple figures or views that show it from different view angles, sliced open to reveal internal parts, or disassembled. A single sheet of paper may contain several figures. The figures must not touch each other, and must be far enough apart so that they are clearly separated.

Orthogonal and Perspective Views

Orthogonal (engineering) and perspective figures are the most commonly used figures. (See Chapter 1 for details.) Perspective figures are easier to understand than orthogonal figures, but they are also more difficult to draw. To save work, you may illustrate your invention solely with orthogonal figures, unless they are too difficult to understand, in which case you should add one or more perspective figures.

TIP

Choose a view angle carefully. The angle of a perspective figure should be chosen carefully, so that as many of your invention's features as possible are clearly visible. If one perspective figure cannot show all the important features, additional perspective figures should be used. It is best to make the first drawing in an application a perspective figure to provide the reader—for example, the patent examiner, a judge, or a potential licensee—with a general understanding of the invention.

Exploded Views

The comprehension of some inventions may be enhanced by an exploded view (figure), which shows the device disassembled. The constituent parts are separated as far as necessary to show the essential details of each one. Each part is preferably moved out along a predetermined axis, but an individual part may be oriented in any position necessary to show its essential details, so long as projection lines are added to show how the part was moved out. An exploded view should always be accompanied by another figure showing the parts assembled, as shown in Illustration 6.5. Exploded views are generally unnecessary, because internal parts are usually better illustrated with sectional views (discussed below). If you wish to use exploded views, note the following about brackets and projection lines.

Brackets. As shown in Illustration 6.6, unconnected parts must be "enclosed" by a bracket to show that they belong to the same figure. The bracket can be oriented in any position. The parts in Illustration 6.7 are purposely positioned so that they are all touching to eliminate the need for a bracket, but such positioning is not as clear as that of Illustration 6.6. No bracket is needed for an exploded view, even if the parts are unconnected, if it is the only figure on a sheet. Note that the exploded pipe fittings of Illustration 6.6 and Illustration 6.7 are positioned along a straight line because they share a common axis.

Projection lines. The parts in Illustration 6.8 do not lie along a single axis, so each part is separated as if it is pulled in a straight line from its assembled position or moved out. Projection lines (the dot-dashed lines) are provided to show how the parts fit together. As shown in Illustration 6.9, when space constraints prevent the parts from being positioned in straight lines from their assembled positions, zigzagged projection lines can be used. No brackets are necessary in Illustration 6.8 and Illustration 6.9 because the projection lines connect all the parts. Projection lines should always be provided when parts are not separated linearly, so as to make their assembly clear.

Partial Views

A very long object that cannot fit onto a single sheet without making the details too small can be broken up, so that each piece can be shown larger than it could have been if the object is shown whole, as long as there is no loss in comprehension. There are several ways to do this:

- Break it into two or more pieces to fit them onto a single sheet, such as in Illustration 6.10. A simple, long bar is used to illustrate the point. The pieces should be connected by projection lines to show how they fit together. If no projection lines are used, a bracket should be used. See above for details on the use of brackets.
- Shorten it by removing a section, as shown in Illustration 6.11, but no important details should be removed. Again, a simple, long bar is used to illustrate the point. It is broken in three places to show the three conventional ways for representing a shortened object. The left break is the

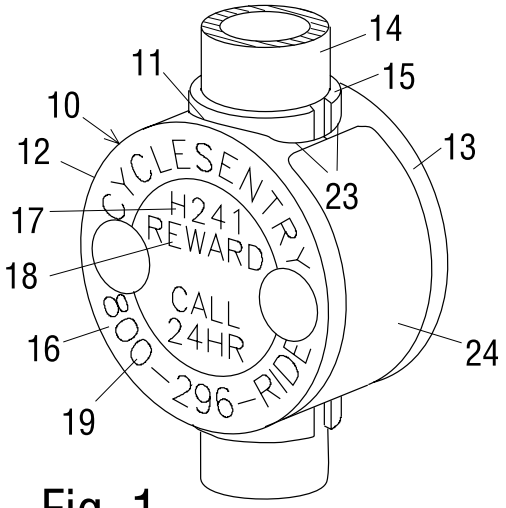


Fig. 1

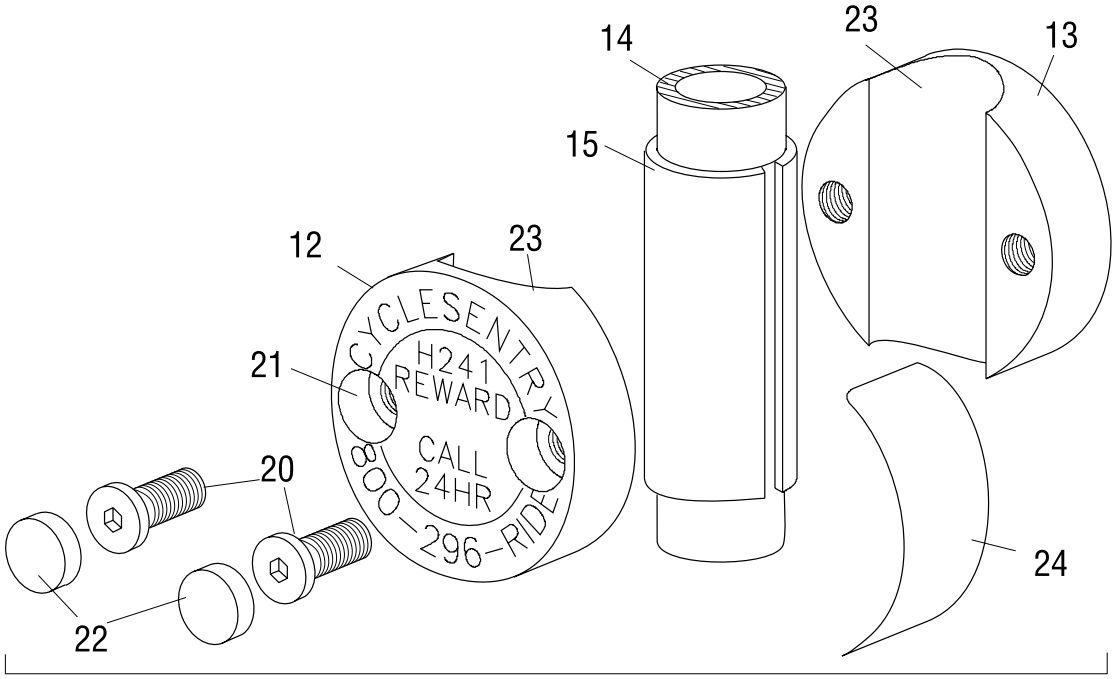


Fig. 2

Illustration 6.5—Exploded View Accompanied by Assembled View

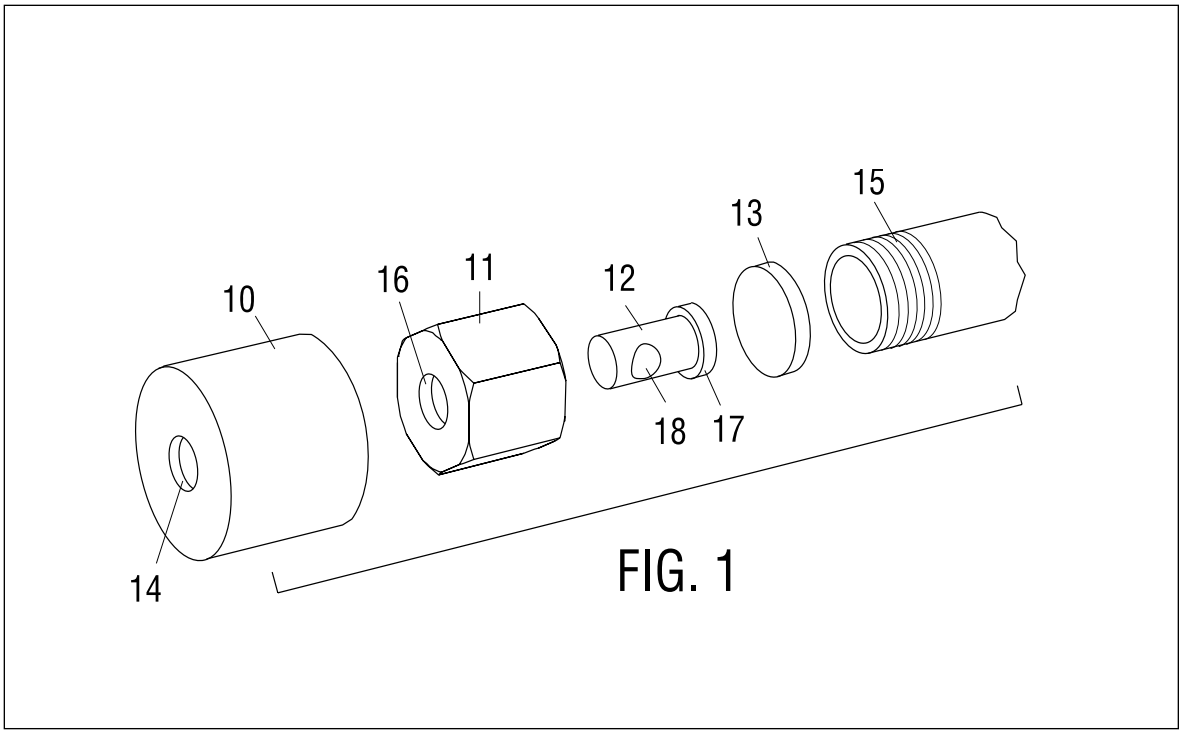


Illustration 6.6—Exploded View With Bracket

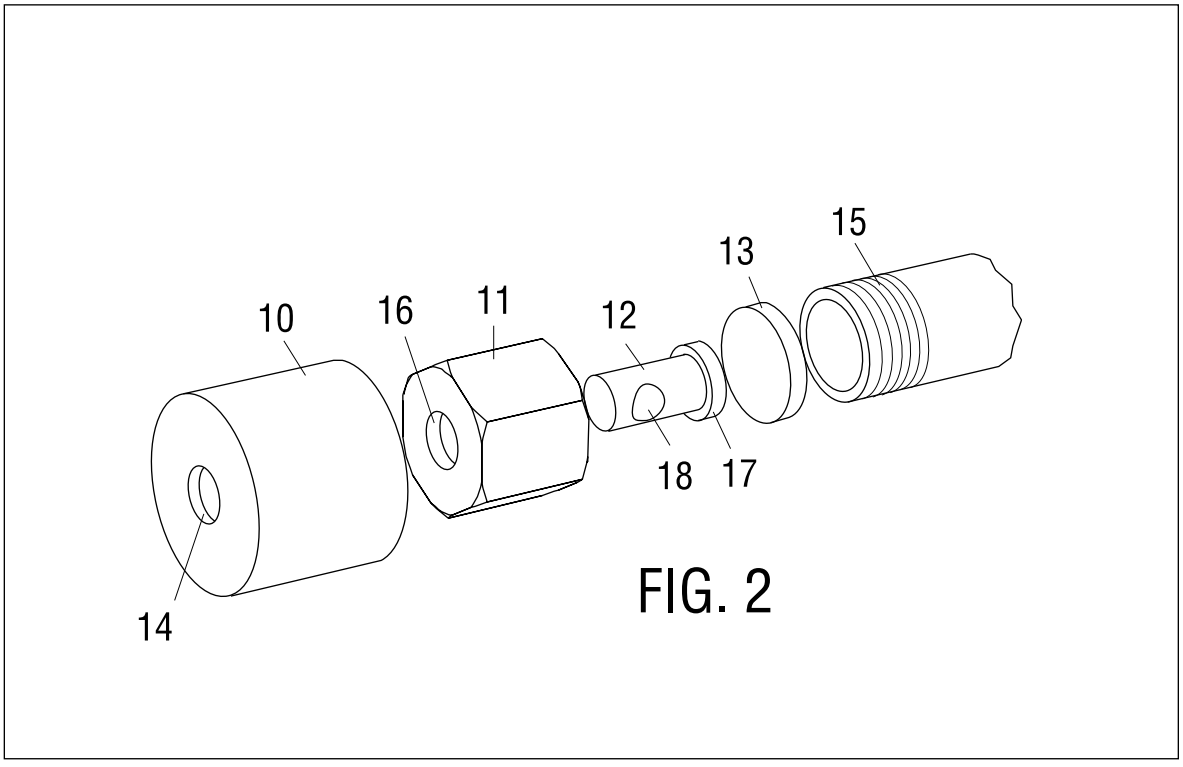


Illustration 6.7—Exploded View Without Bracket

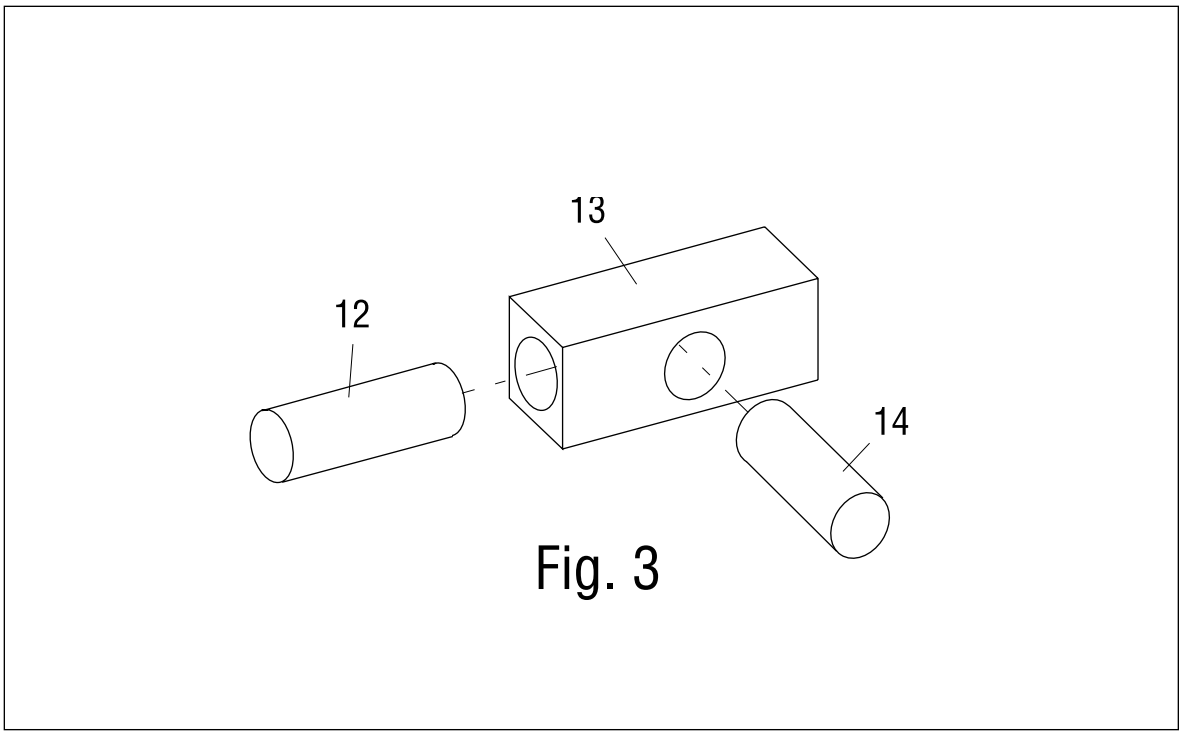


Illustration 6.8—Exploded View With Projection Lines

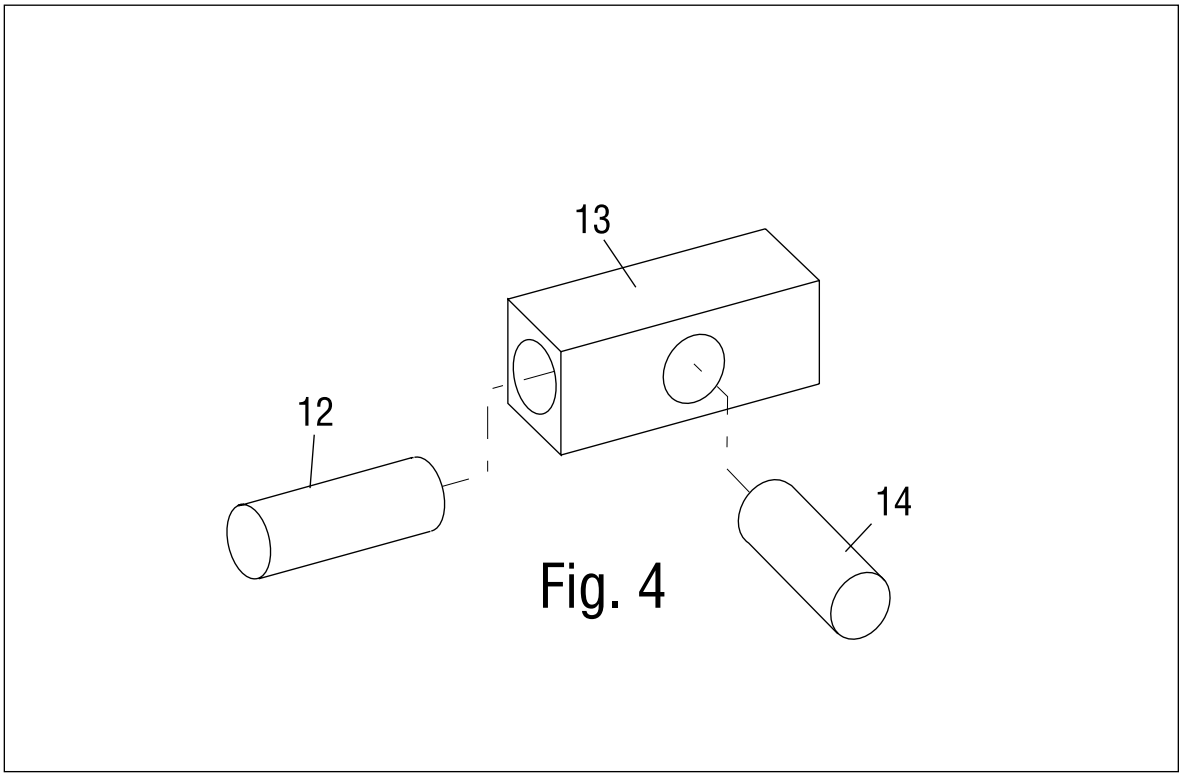


Illustration 6.9—Exploded View With Zigzagged Projection Lines

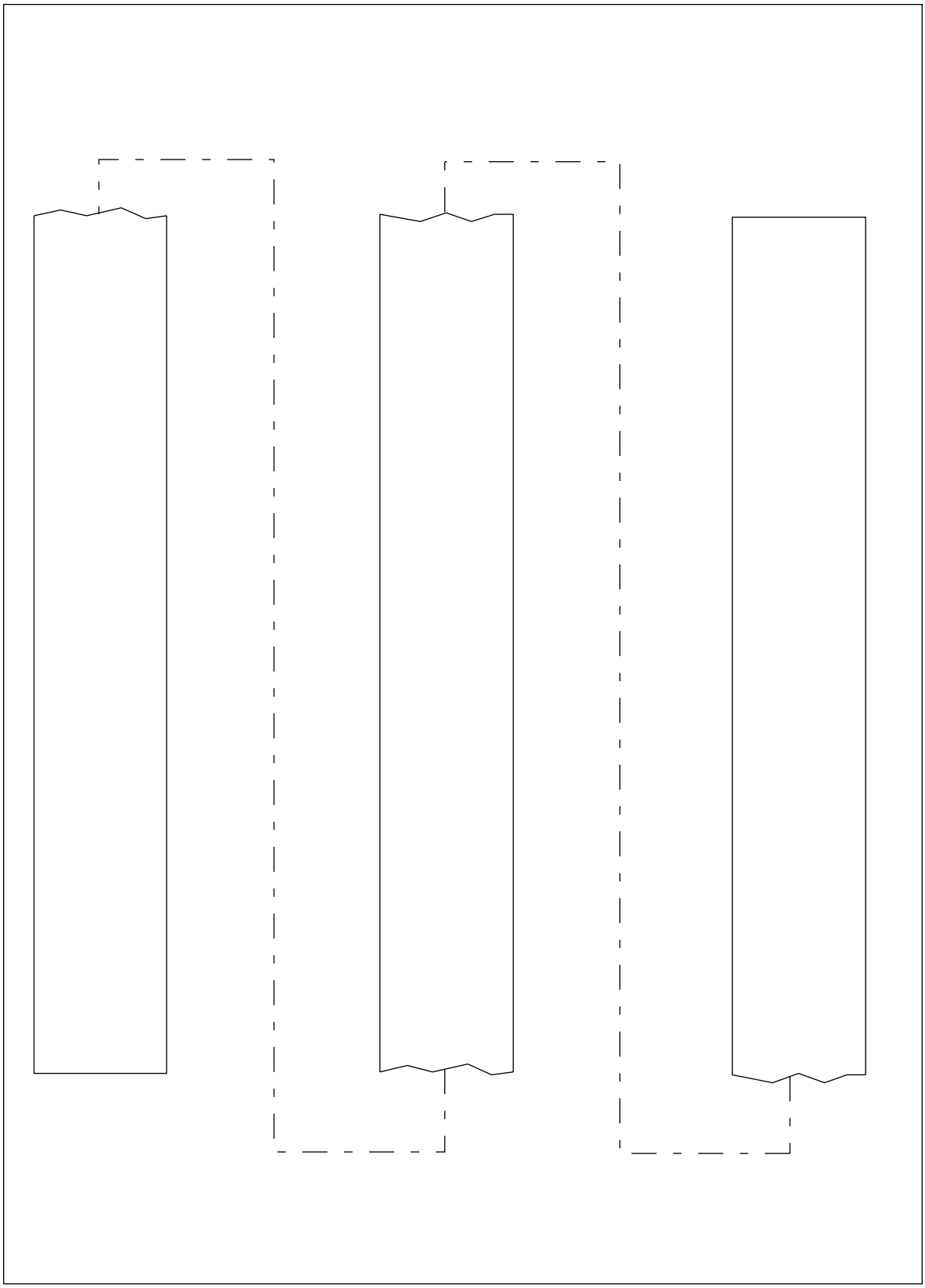


Illustration 6.10—Long Object Broken to Fit Sheet

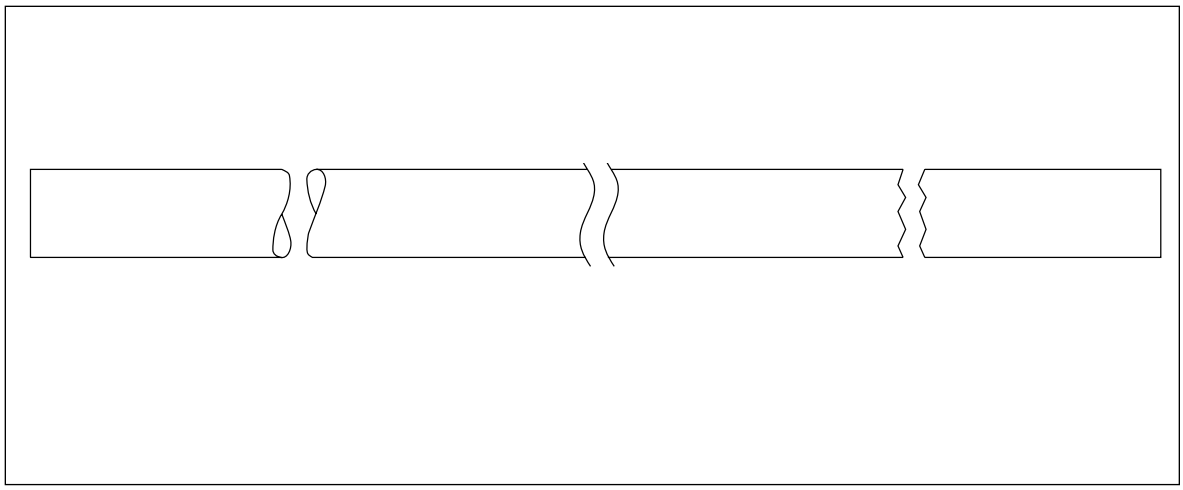


Illustration 6.11—Three Ways to Shorten a Long Object

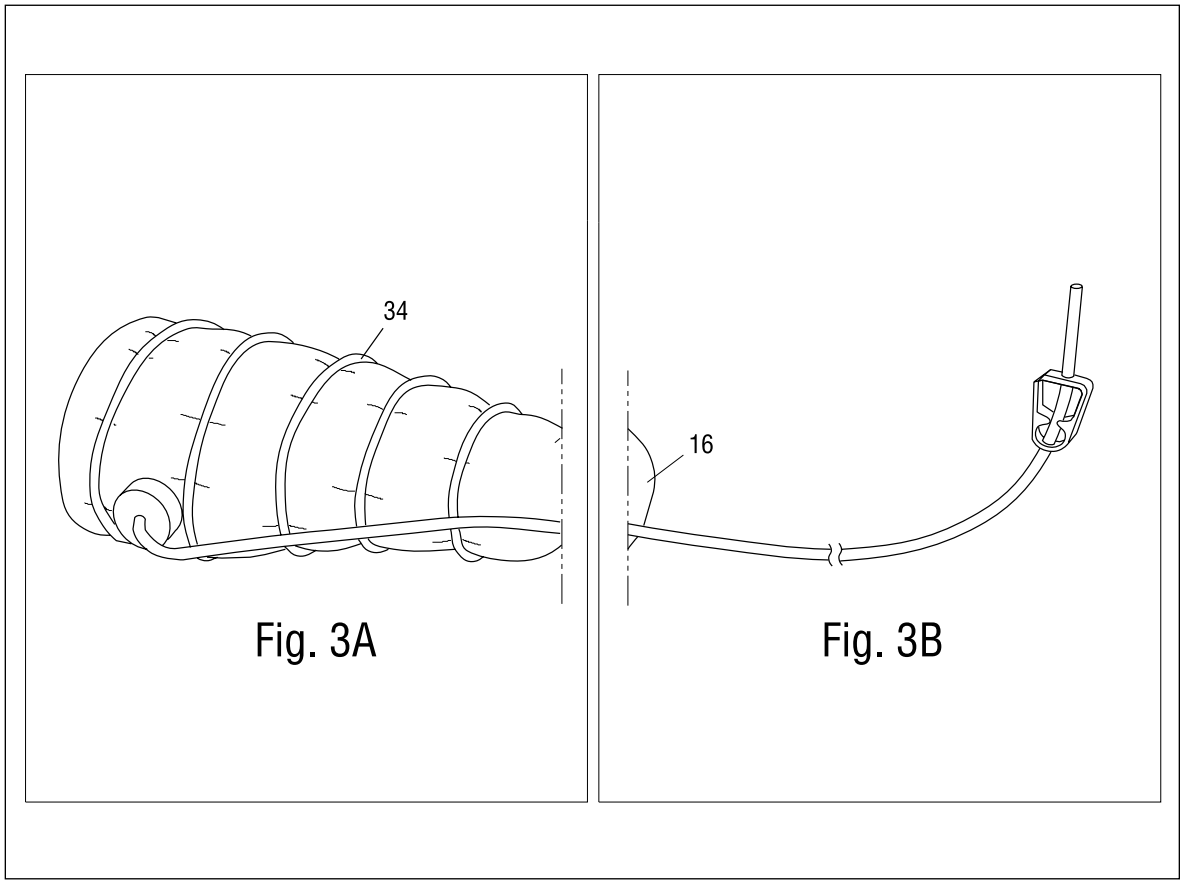


Illustration 6.12—Spreading a Large Figure Onto Multiple Sheets

type typically used for a cylindrical object, whereas the other two types can be used for anything.

- Spread it across two or more sheets, such as the drinking bag in Illustration 6.12. The views must be arranged on each sheet so that the sheets can be tiled (positioned like bathroom tiles) next to each other to assemble the complete figure. A dot-dot-dash (phantom) line should be provided to denote the broken edge of each partial view. Any arrangement of the sheets can be used, for example, side-to-side, top-to-bottom, and rectangular array, as long as the sheets can be assembled without ambiguity or blocking the drawings on each other. Each partial view should be labeled with a figure number having a letter suffix, for example, Fig. 3A and Fig. 3B.

Also, an invention can have a part broken off and omitted if comprehension is not affected. The broken edge is customarily made jagged to indicate its nature, such as the portions of element 14 below its horizontal surface in Illustration 6.13.

Sectional Views

If a device has hidden parts or internal features that should be shown, one or more sectional (cutaway) views may be used. Illustration 6.14 shows a general view of a box, Fig. 1, and a sectional view, Fig. 2, of the hollow interior of the box. Whenever a sectional view is used, section lines (a broken line with perpendicular end arrows) should be placed on a general view, such as in Fig. 1. The broken line between the arrows defines the sectioning plane, that is, where the object is sliced. The arrows indicate the view direction. Numbers corresponding to the figure number of the sectional view must be placed next to the arrows, and sized about 5 mm or ⅕" high. If the general view is orthogonal, such as in Illustration 6.14, the position of the sectioning plane is assumed to be perpendicular to the drawing sheet (the sheet of paper the drawing is on).

For example, the broken line in Fig. 1 indicates that the object is sliced at about its midpoint. The arrows indicate that, to see the sliced section as it appears in Fig. 2, a person must be standing to the right of the object and looking toward its left end. The number "2" is placed at the tip of each arrow, to indicate that the sectional view is Fig. 2. The broken line may be referred to in the specification (description portion of the application) as section "line 2—2." For example, Fig. 2 shows a sectional view of the box of Fig. 1 taken at the sectioning plane and in the direction indicated by section lines 2—2.

Perspective General View

Instead of an orthogonal general view, such as in Illustration 6.14, you can use a perspective general view, which is easier to understand. However, in a perspective general view, the sectioning plane may be positioned at any angle to the drawing sheet, so greater care should be taken to make its orientation clear. Illustration 6.15 shows how the broken line and arrows are drawn in a perspective general view:

1. "Slice" the object with an imaginary, rectangular sectioning plane. The dashed lines are only for illustrating the plane and where it meets the object; they should not appear in a patent drawing.
2. Draw the broken line on the sectioning plane. Imagine threading a string through the object; the broken line is the part of the string that remains visible.
3. Position the arrows at the ends of the broken line, so that they are perpendicular to the imaginary plane and pointed in the direction of the view.

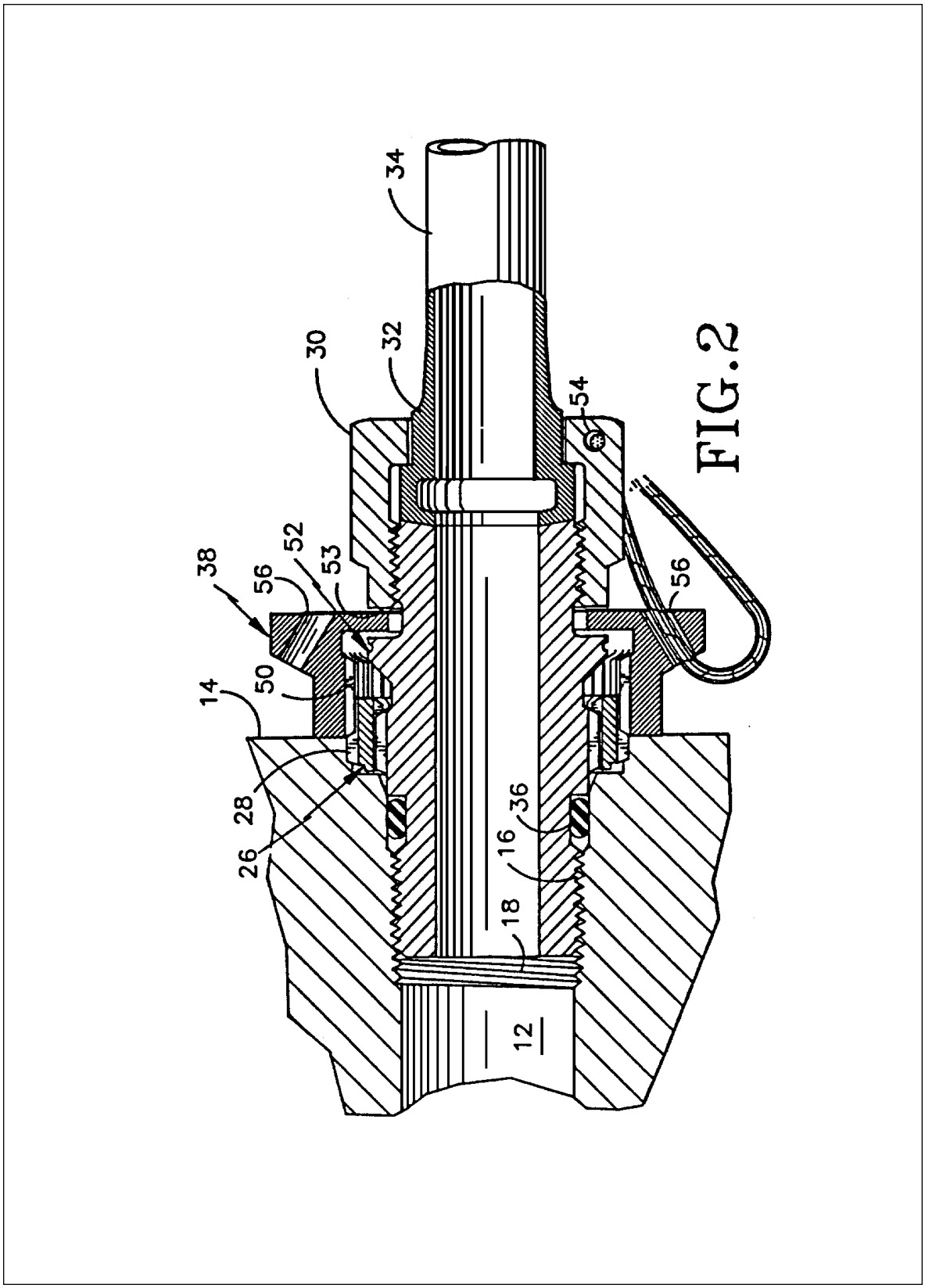


Illustration 6.13—Broken View

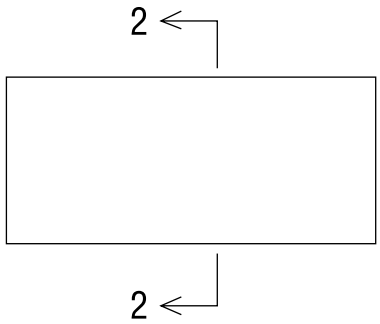


Fig. 1

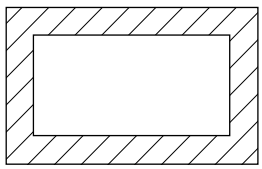
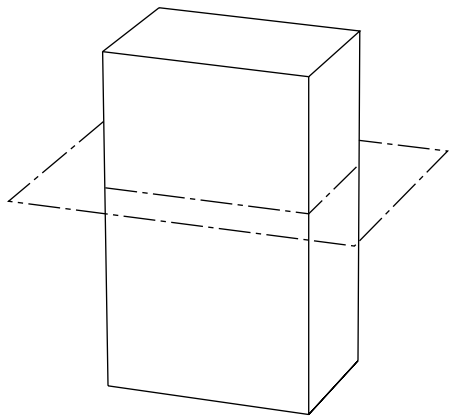
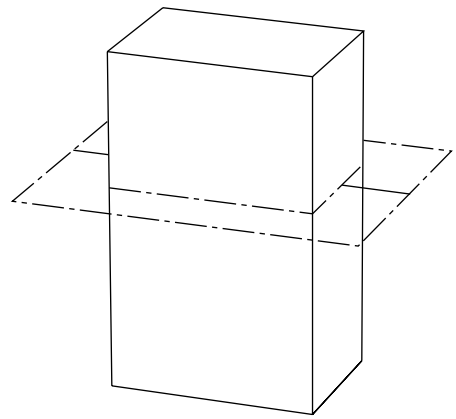


Fig. 2

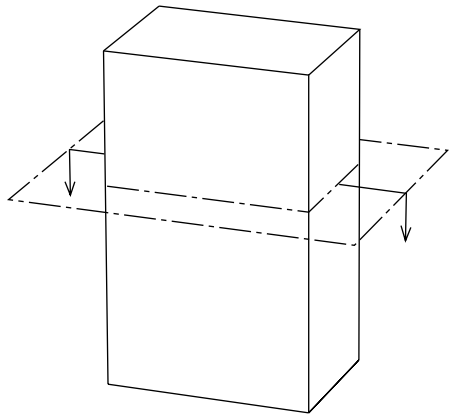
Illustration 6.14—Sectional View



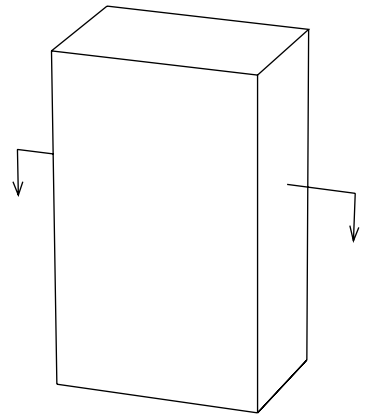
Step 1



Step 2



Step 3



Step 4

Illustration 6.15—Positioning Broken Lines and Arrows in Perspective General View

4. The finished broken line with arrows appears in the patent drawing, without the imaginary plane.

The sectioning plane in the illustration shown is horizontal with respect to the object, but a sectioning plane may be arranged in any orientation desired.

Partial Sectional View

In contrast to Illustration 6.14 of an object completely sliced in half, Illustration 6.16 is a partial sectional view, in which a motor or generator is shown with a portion cut away. The delineation between the sectional and general views is preferably jagged to clearly show that it is a sectional cut. The nonsectioned portion of the motor or generator provides a built-in general view, so that no broken line and arrows are needed. Partial sectional views may be used when it is not necessary to show all of an object's interior.

Orthogonal Versus Perspective Sectional Views

The easiest type of sectional view to make is the orthogonal sectional view, such as those shown in Illustrations 6.14 and 6.16, in which the viewer is looking at the exposed surface at a right angle, or head-on. However, just as with other orthogonal views, orthogonal sectional views tend to be difficult to understand, particularly if the object depicted is complicated. A much clearer type of sectional view is the perspective sectional, such as Fig. 3 in Illustration 6.17. The general view for a perspective sectional should also be a perspective of the same angle, which in this illustration is Fig. 2. A broken line with arrows is not necessary in this case, because the orientation of the sectioned object, and where the section is taken, are clear when the two views are compared.

Line Types and Hatching

The "exposed surfaces" of a sectioned part must be covered by hatching, which are oblique parallel lines. Crisscross hatch lines, such as a weave pattern, cannot be used. Also double line hatching (lines arranged in pairs) is forbidden. The angle of hatching is ideally 45 degrees from horizontal. The hatching in adjacent parts should be at opposite angles to clearly show that they represent different parts. If there are more than two adjacent parts, their hatch styles and angles can be varied to distinguish them, as shown in Illustration 6.18. Different areas of a continuous part, such as the two ends of the sectioned ring in Illustration 6.19, should have the same hatch style, spacing, and angle.

The hatch lines should be thinner than the edge lines (lines representing the outline and edges of the object) to avoid confusion. In Illustration 6.20, the figure with thinner hatch lines is clearly easier to understand than the one with identical line widths throughout.

In addition to the continuous lines shown in Figs 18 to 20, the PTO recognizes three types of discontinuous lines, as follows: (1) Hidden lines (even dashes) to indicate (a) an area which is shown enlarged in a different figure (Fig 6-21) or (b) a hidden part (Fig 8-21), (2) Phantom lines (long dash followed by two short dashes, repeated) for components that are not part of the invention (Fig 8-21), and (3) Projection lines (long dash followed by a single short dash, repeated) for showing how separated parts fit together (Fig 8-21).

Enlarged Views

A portion of a device may be enlarged in a separate figure to show details. Dashed circles are used to surround the enlarged portion in the general view and the enlarged view, as shown in Illustration 6.21. A reference number in the

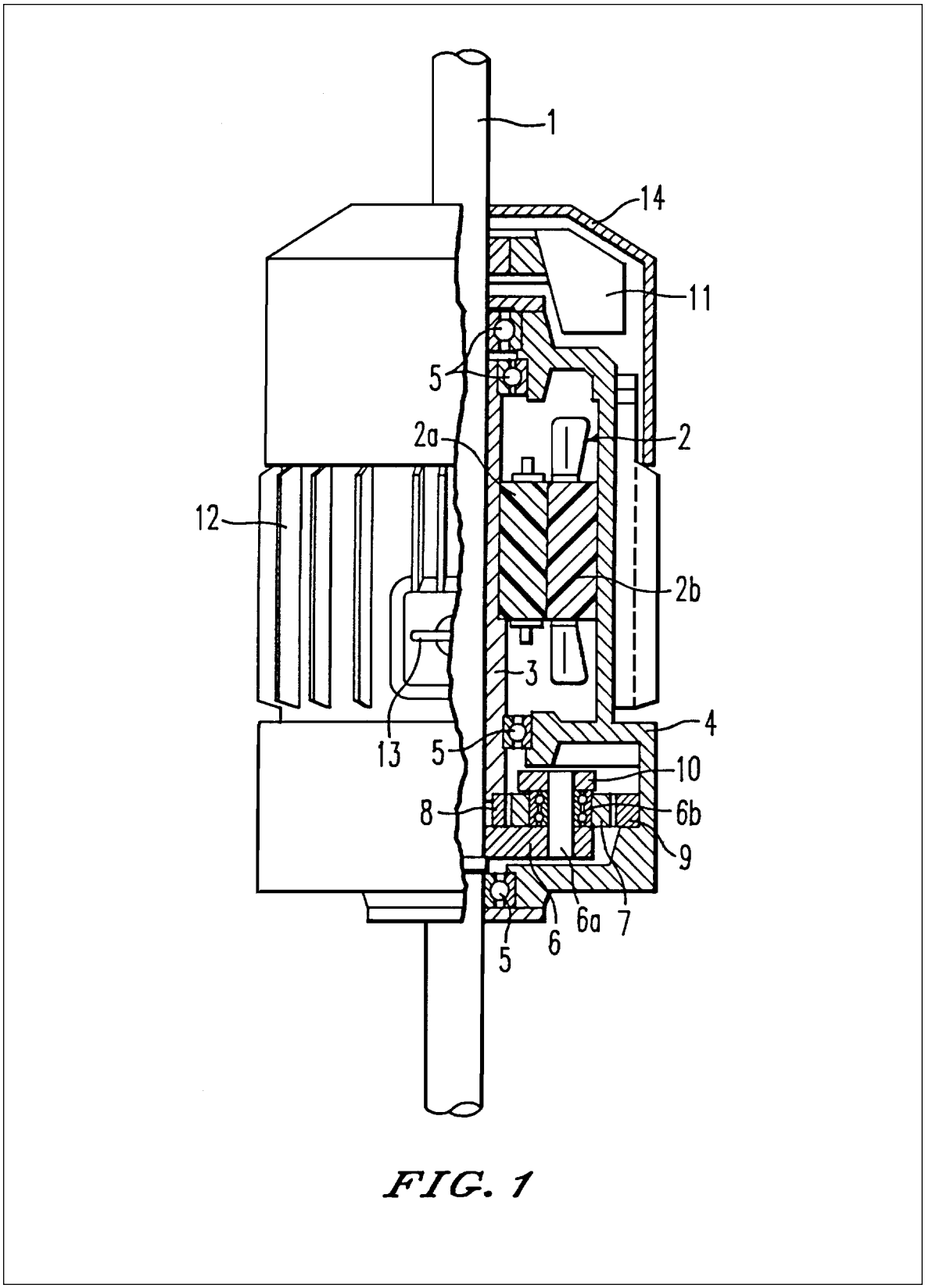


FIG. 1

Illustration 6.16—Partial Sectional View

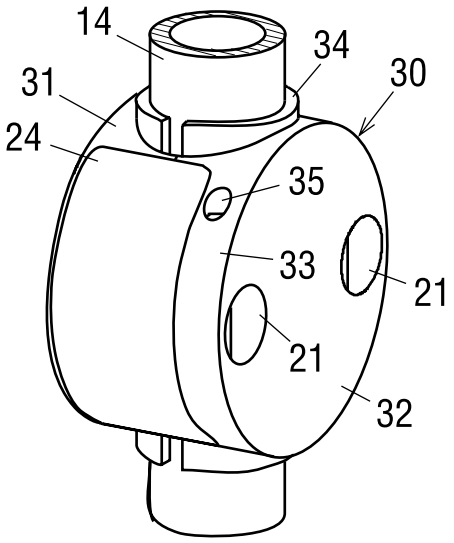


FIG. 2

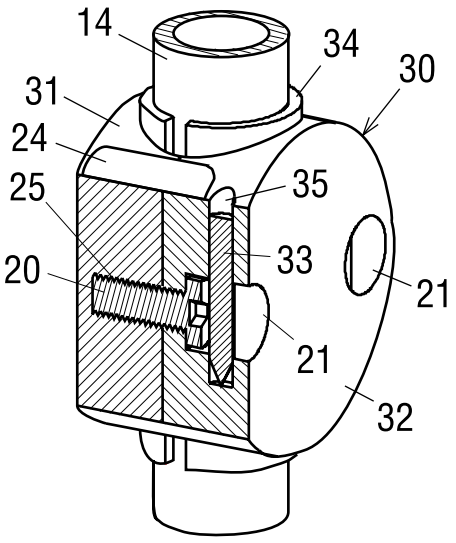


FIG. 3

Illustration 6.17—Perspective Sectional View

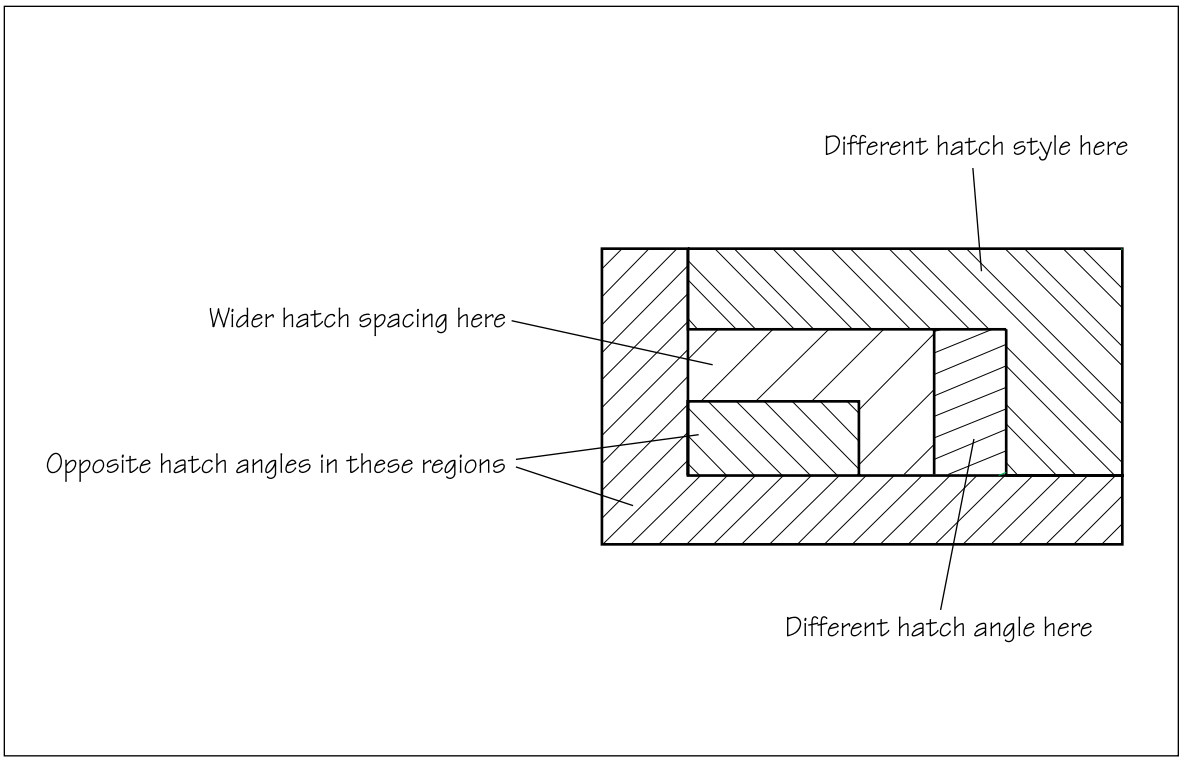


Illustration 6.18—Vary Hatching to Distinguish Adjacent Regions

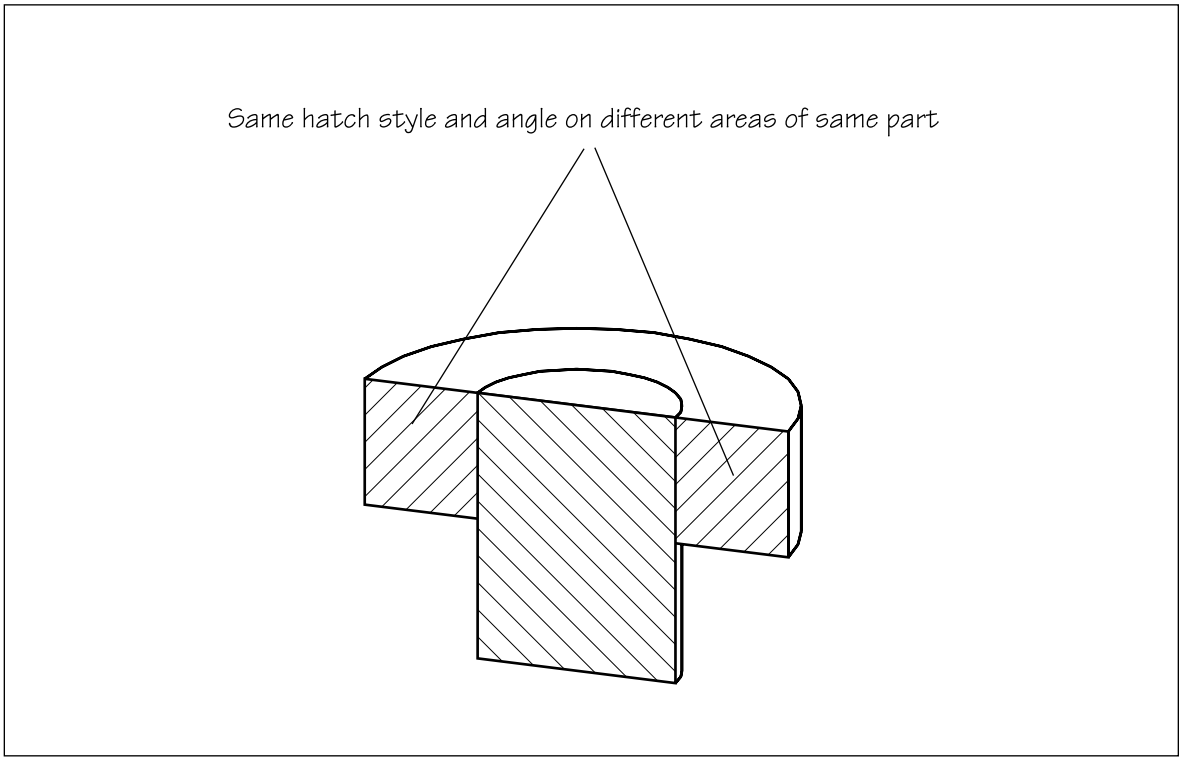
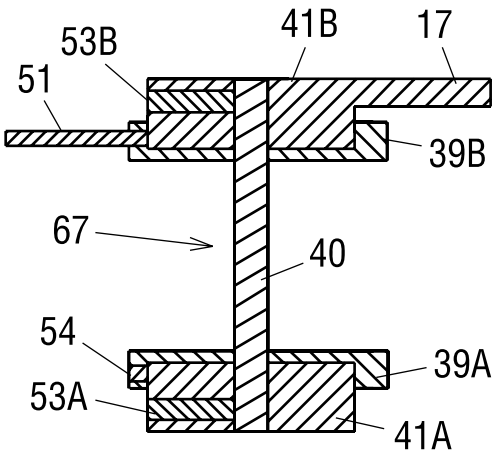
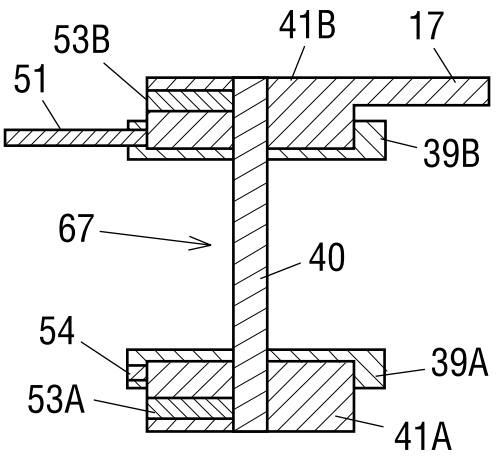


Illustration 6.19—Hatch Angle on Different Areas of Same Part



Thick hatch lines make a drawing confusing.



Thin hatch lines make a drawing clearer.

Illustration 6.20—Thin Versus Thick Hatch Lines

FIG. 7

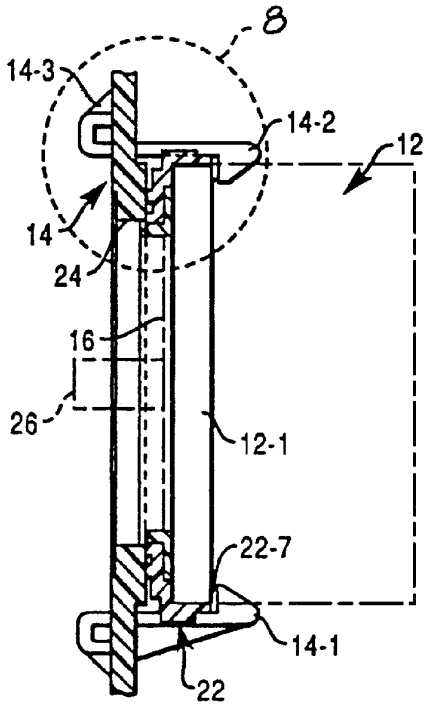


FIG. 8

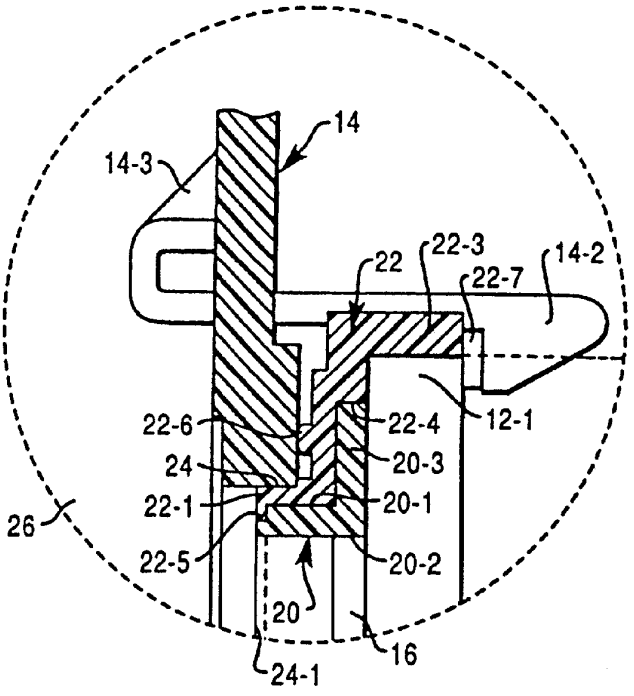


Illustration 6.21—Enlarged View

general view, which is "8" in this illustration, is applied to the dashed circle to indicate the figure number of the enlarged view, which is Fig. 8 in this illustration.

Inventions With Moving Parts

An invention with moving parts should be shown with the parts positioned in an initial or at-rest condition. Movement of the parts may be shown in several different ways.

Arrow. If the movement of a part is simple, it may simply be indicated by an arrow, such as the rotation of the hinged arm in Illustration 6.22.

Moved part. If it is necessary for comprehension, a part may be drawn in solid lines to show it in its initial position and drawn in phantom lines (dot-dot-dash lines) in the same figure to show it in a moved position. This should be done only if there is no risk of confusion. Illustration 6.23 shows both the original and moved positions of a sleeve on a rod.

Separate figures. The initial position of a part may be shown in solid lines in one figure, and its moved position in solid lines in a separate figure, such as the sleeve and rod in Illustration 6.24. The movement of the part may be indicated by an optional arrow. Separate figures should not be connected.

Long sequence. A complicated invention should be illustrated with a sequence of figures to clearly show the movements and interactions of all the parts in as many distinct steps as necessary. Illustrations 6.25 through 6.32 show the different figures for illustrating a fairly complicated invention—a dual-cycle toilet flusher that provides selectable small- and big-capacity flushes.

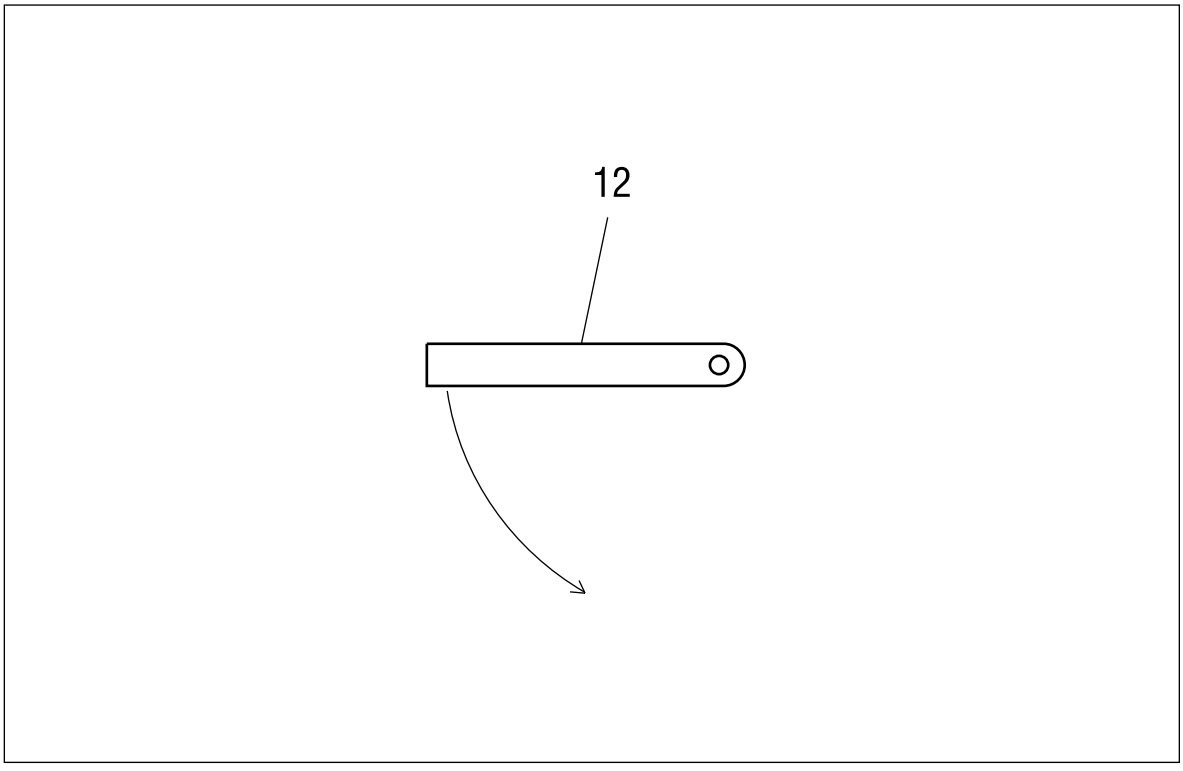


Illustration 6.22—Arrow Indicating Movement

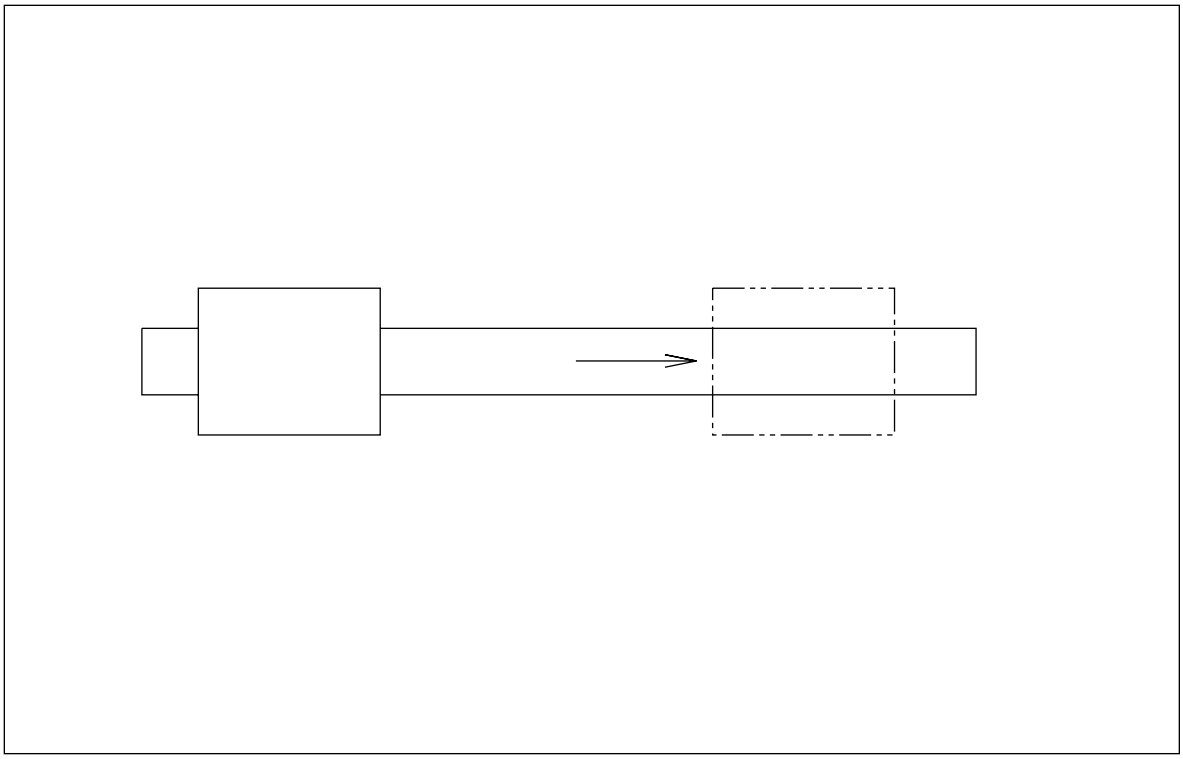


Illustration 6.23—Representing Moved Part With Phantom Lines

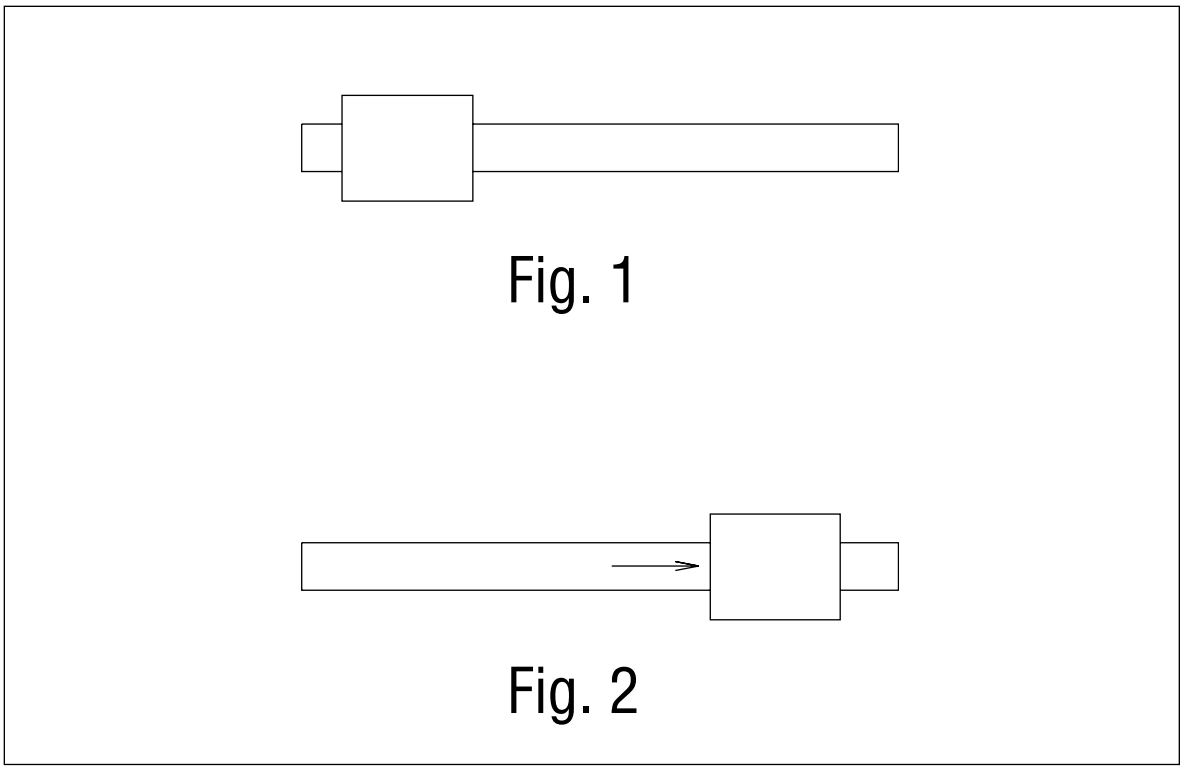


Illustration 6.24—Representing Moved Part With Separate Figures

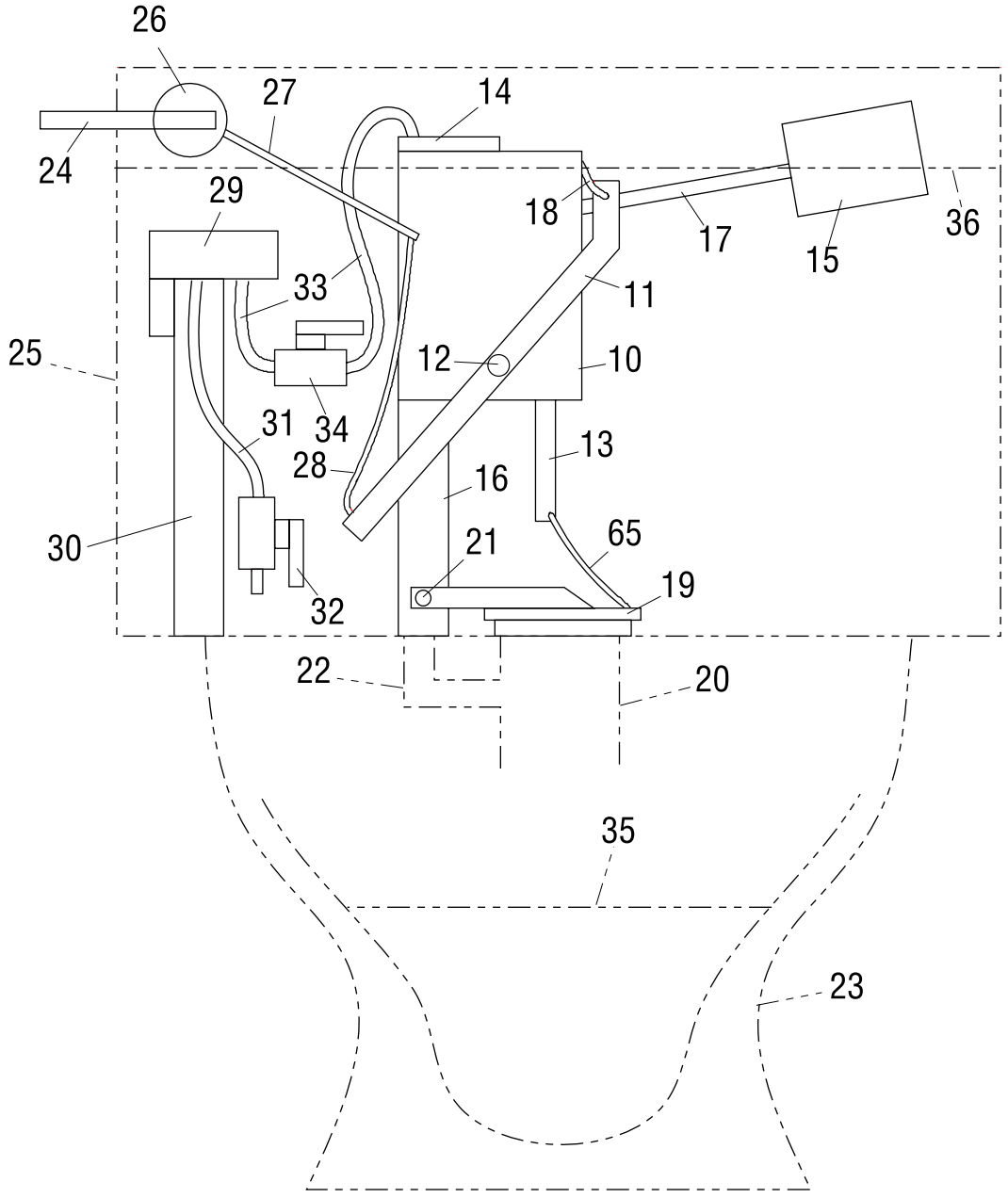


FIG. 1

Illustration 6.25—Illustration of Structure and Operation of Complicated Invention

Fig. 1 of Illustration 6.25 is a general view that shows the device installed in a conventional water tank. Note that the toilet bowl and the water tank, which are not part of the invention, are shown in phantom (dot-dot-dash) lines. Elements that are not part of the invention may be, but are not required to be, shown in phantom lines. Because the flushing mechanism is inside the tank, using phantom lines for the tank enables the flushing mechanism to be shown in solid lines. On the other hand, if the tank is shown in solid lines, the flushing mechanism would have to be shown in hidden (dashed) lines, which would make it harder to draw and much harder to read.

Another alternative is to show the flushing mechanism in solid lines, and the tank cut away to expose the flushing mechanism. However, this would have required a separate, non-cutaway general view with a broken line and arrows to indicate the sectioning plane and view direction (see above, on sectional views). Therefore, in this case, showing the tank and toilet bowl in phantom lines saves work and makes the invention easier to understand.

Fig. 2A of Illustration 6.26 is a detailed general view of the flushing mechanism alone in an initial or at-rest condition. It is provided in addition to Fig. 1, because the flushing mechanism in Fig. 1 is too small to show all of its details. Showing the flushing mechanism alone in a separate figure allows it to be drawn big enough to occupy the entire sheet, so that all the details can be clearly seen. Note that Fig. 2A is an easy-to-understand perspective view. Also note that water level 36 is shown as a phantom line. Fig. 2B is a top sectional view of a cam assembly 67, which includes nested, rotating elements on both sides of the flushing mechanism. Showing cam assembly 67 in a top sectional view allows both sides, as well as the relationship of all the nested elements, to be clearly shown. Without the top sectional view, several additional perspective views, which are more difficult to draw, would have to be used to convey the same information. Note broken line 2B—2B with arrows indicates the sectioning plane and view direction.

Figs. 3A and 3B of Illustration 6.27 show the flushing mechanism after the flush lever (not shown) has been pressed for a small flush—that is, after the first distinct step in the operation of the mechanism. The device is shown in Fig. 3A with some outer parts omitted to show the position of the inner parts. The description part of the application should note that specific parts are omitted for clarity. For this invention, the statement could be: "In Fig. 3A, housing 10, trigger 43A, cam 39A, and disc 41A (shown in Fig. 2A) are omitted to clearly show the inner mechanisms they would otherwise obscure." The back sides of cam assemblies 67 and 68 are shown, in a separate rear view in Fig. 3B, in positions that correspond to those shown in Fig. 3A. Note that it would not have been possible to clearly show the operation of the mechanism with an orthogonal side view or side sectional view, because of the many layers of parts. Note that drain hole 20 is unconnected to the rest of the device, so a bracket is used to "enclose" them and indicate that all parts belong to the same figure; the bracket is not needed if drain hole 20 touches the rest of the figure.

Illustrations 6.28 through 6.32 show subsequent steps in the operation of the flushing mechanism. Additional outer parts are omitted to show the movement of deeply buried inner parts. The omitted parts can be omitted only if they have been shown in previous figures and are not essential for the understanding of the current figure. Note that Fig. 5 is taken from the opposite side—that is, a rear view to show the operation of the parts on that side. The written description (specification) should state

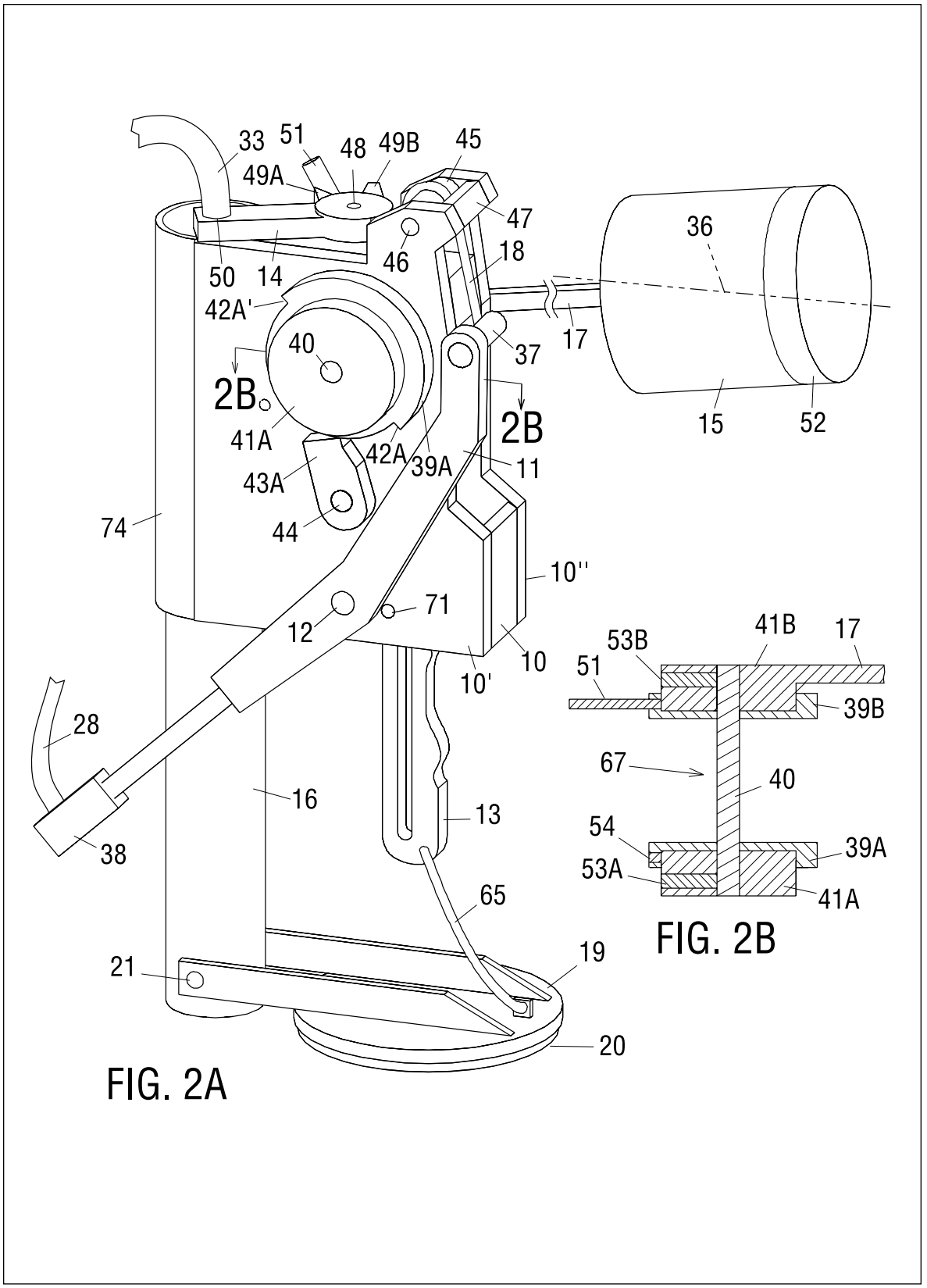


Illustration 6.26—Illustration of Structure and Operation of Complicated Invention

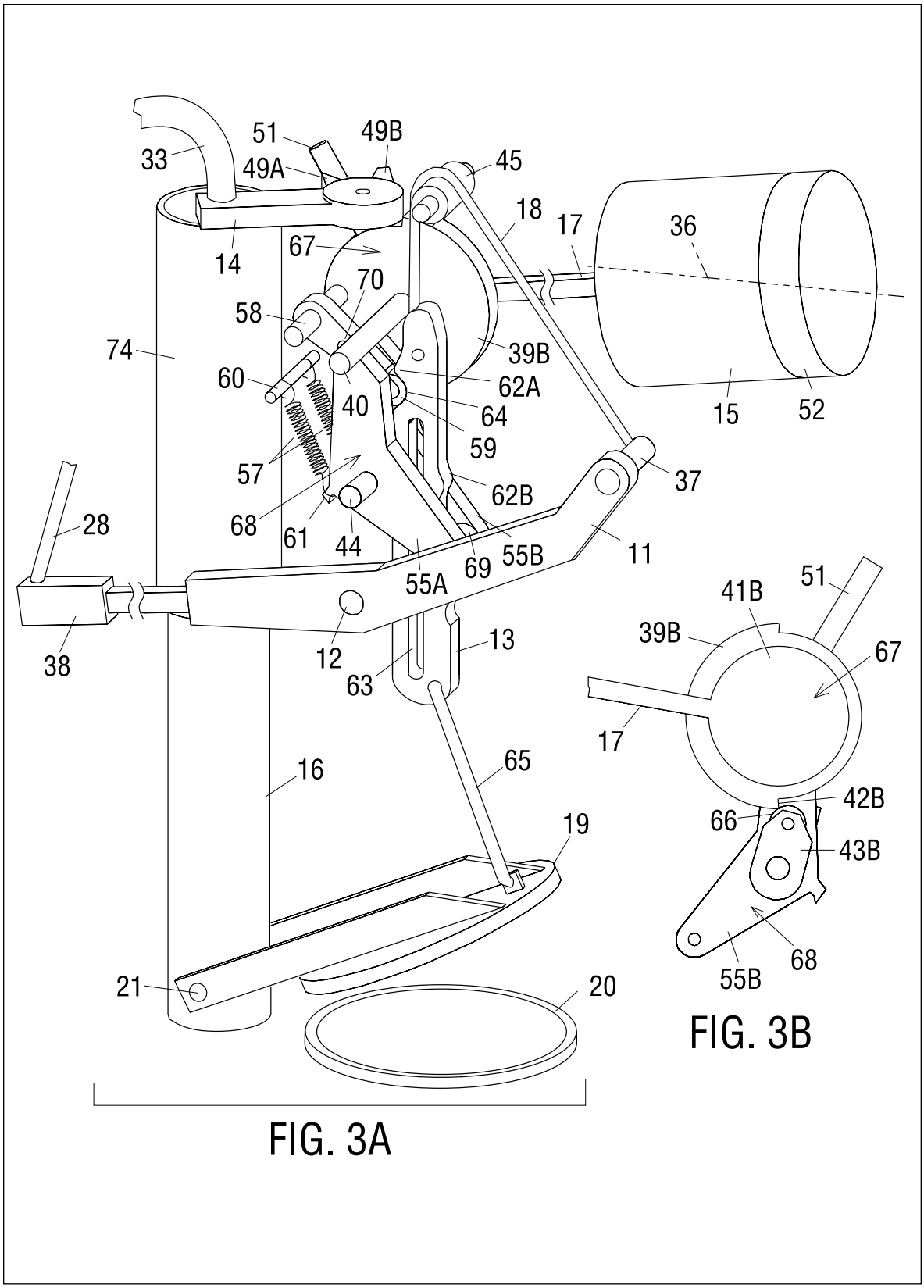


Illustration 6.27—Illustration of Structure and Operation of Complicated Invention

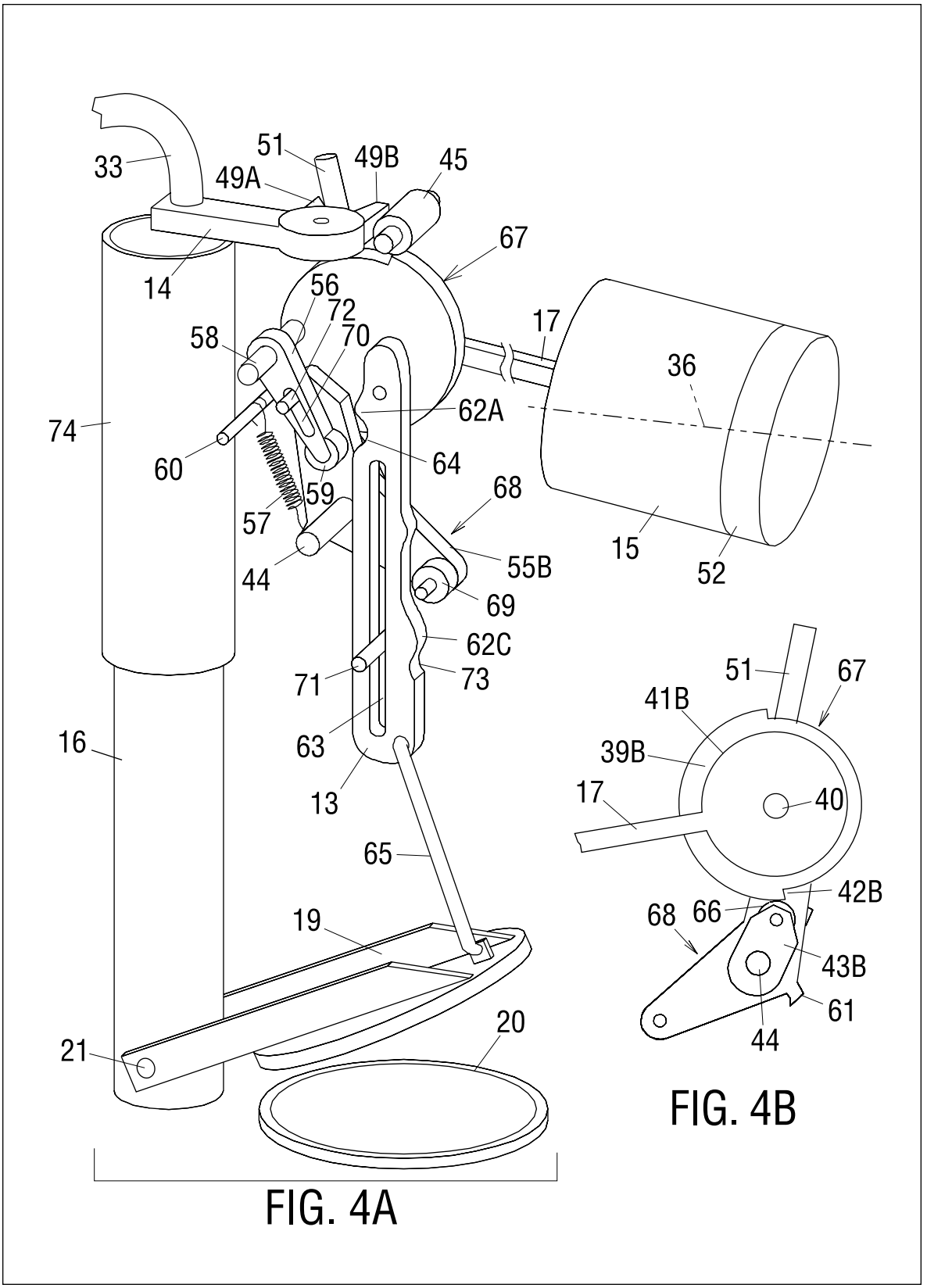


FIG. 4A

FIG. 4B

Illustration 6.28—Illustration of Structure and Operation of Complicated Invention

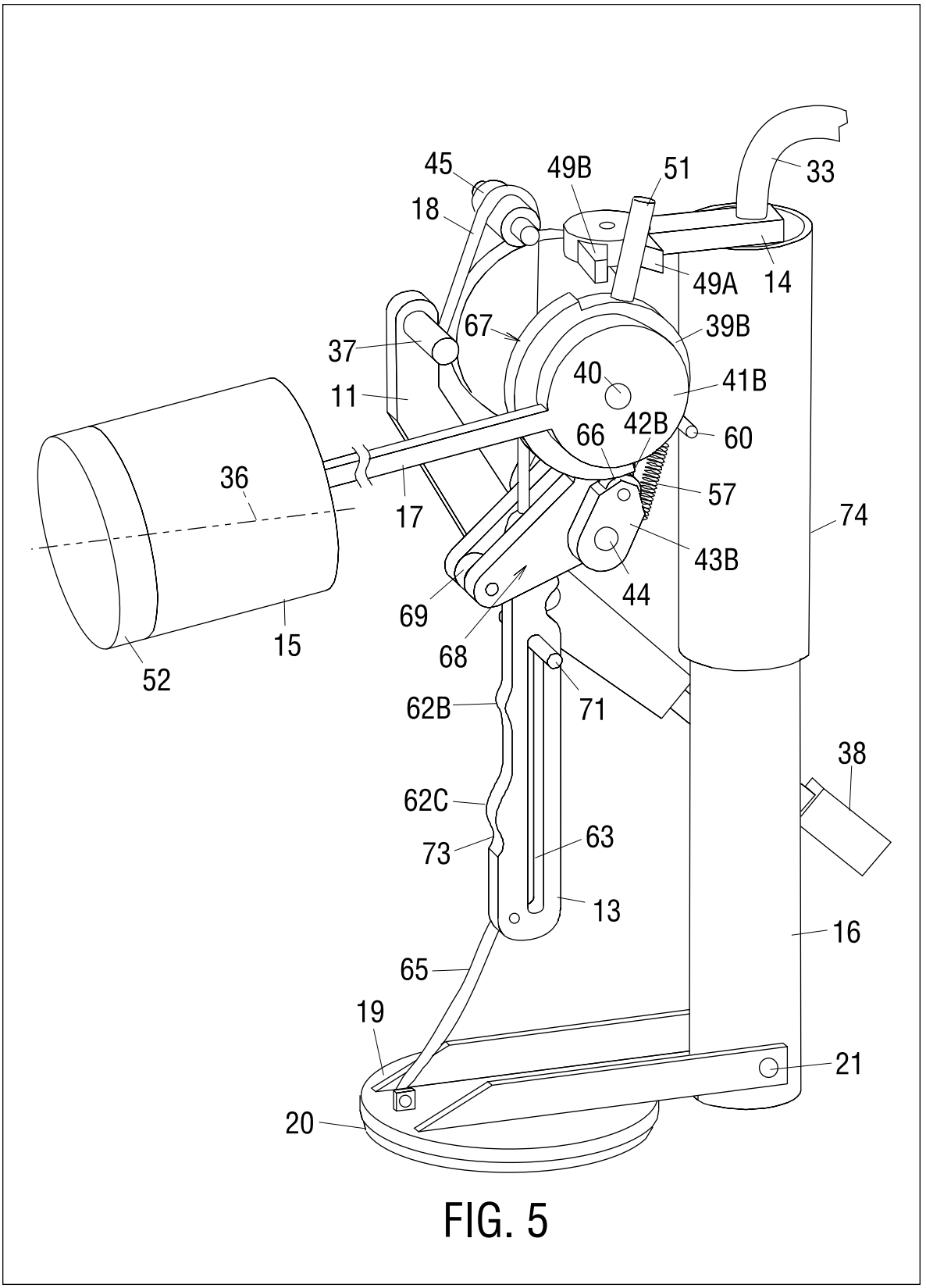


FIG. 5

Illustration 6.29—Illustration of Structure and Operation of Complicated Invention

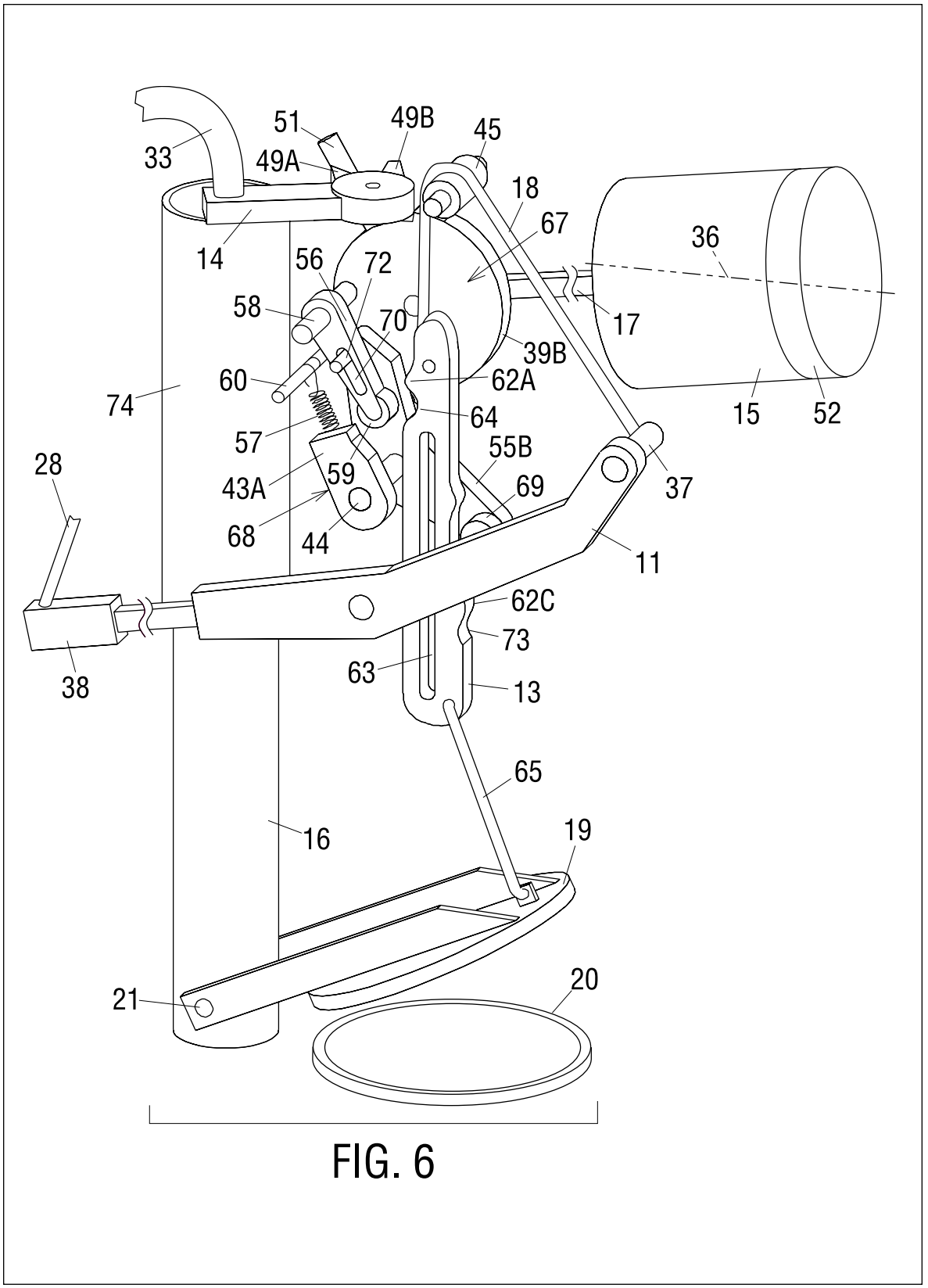


FIG. 6

Illustration 6.30—Illustration of Structure and Operation of Complicated Invention

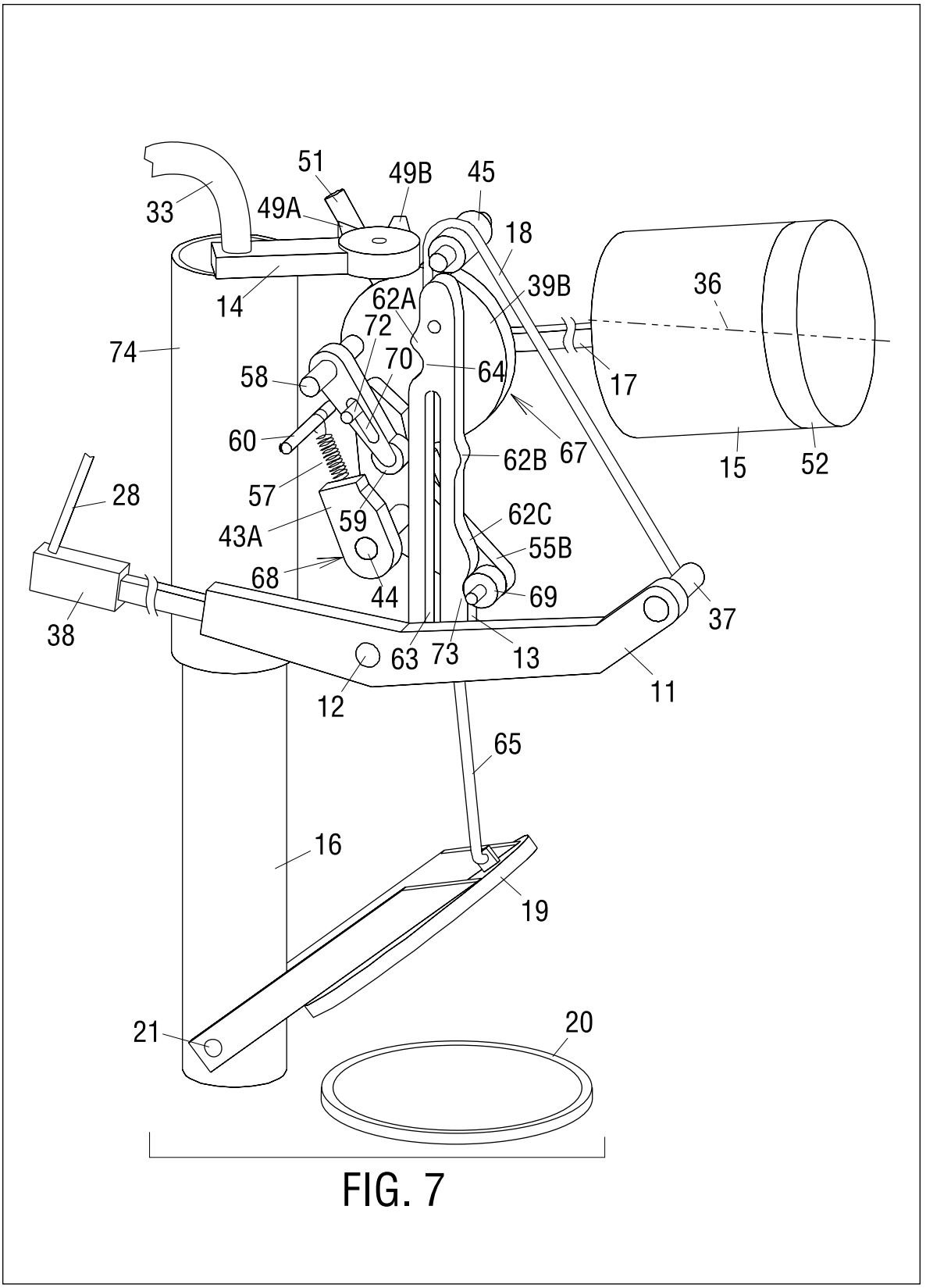


FIG. 7

Illustration 6.31—Illustration of Structure and Operation of Complicated Invention

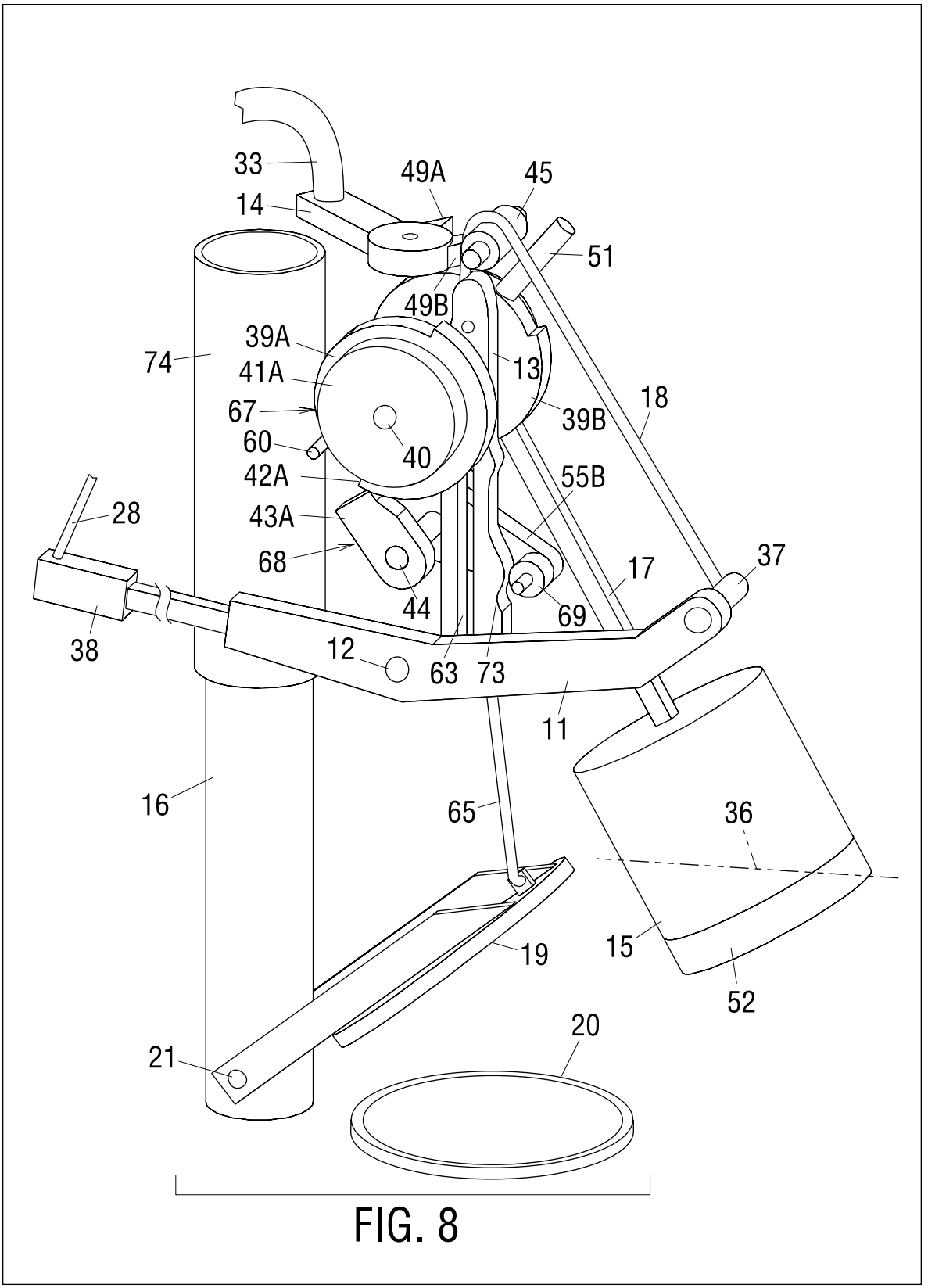


FIG. 8

Illustration 6.32—Illustration of Structure and Operation of Complicated Invention

clearly the side from which a view is taken, and mention that parts are omitted to show others. The sequential figures thus cooperate to clearly show the physical structure and every distinct step in the operation of the flushing mechanism.

Shading

Shading is the representation of shadows on an object to depict surface contour. It is distinguished from hatching, which is applied to sectioned portions of an object.

Shading is not required in utility patent drawings, but it can improve comprehension of figures in some situations. Consider the unshaded cylinder in Illustration 6.33. Is the top open or closed? The shaded versions make it clear. Flat parts may also be lightly shaded, such as the closed top of the cylinder on the lower right. The object should be shaded as if it is illuminated by a light source on the upper left. Refer to Chapter 7 for details on shading techniques.

Graphical Symbols

There are standard symbols for many fields of technology, including electronics, fluid power (hydraulics), computer logic, plumbing, and process flow. Symbols are also considered drawings, so they are subject to the basic drawing requirements discussed in Chapter 8.

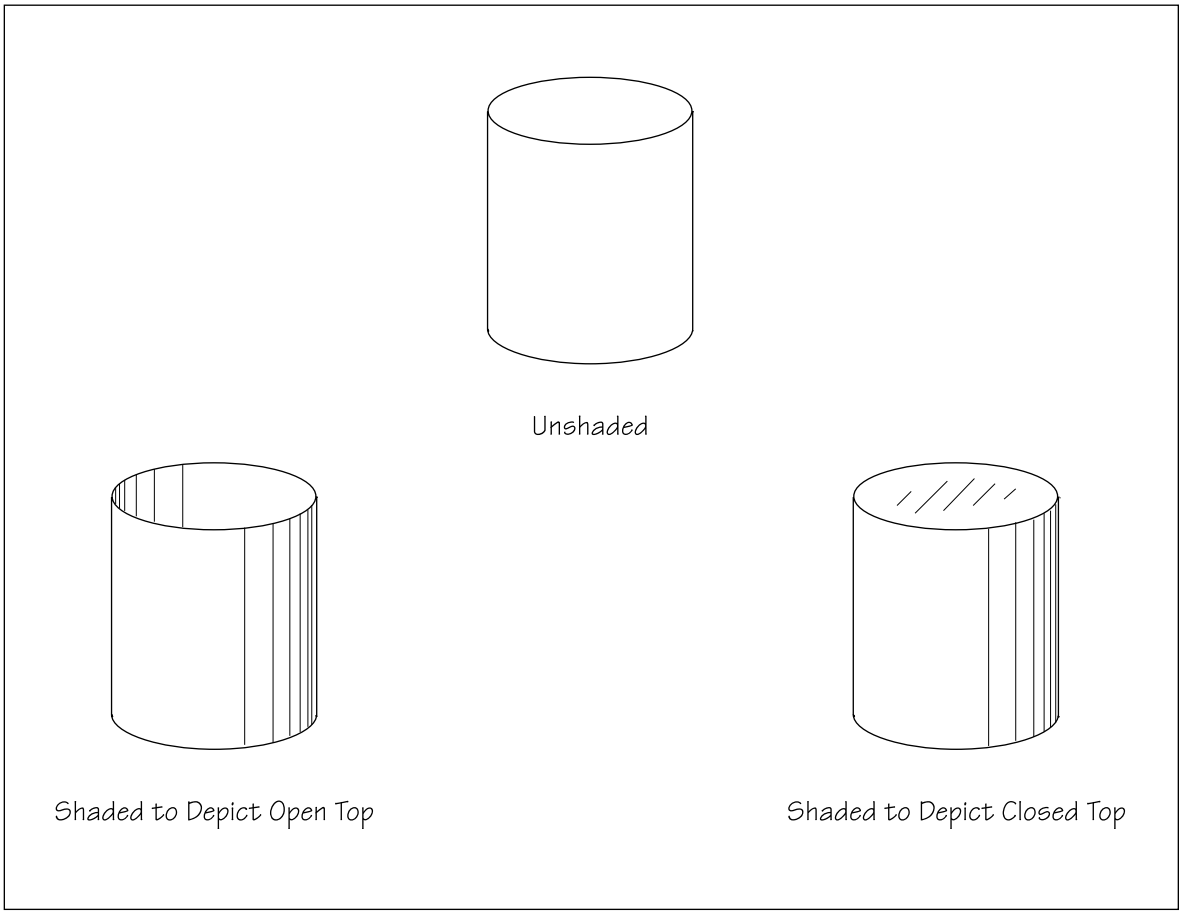


Illustration 6.33—Shading Improves Comprehension

There are too many types of symbols to cover here comprehensively, but some common classes are discussed below.

Electronic Schematics

A simple electrical circuit incorporated into a mechanical device, such as the timer shown in Illustration 6.34, may be drawn as actual parts and wires if the connections are simple enough. Alternatively, a separate schematic or electrical diagram may be used, such as the lamp controller circuit in Illustration 6.35. More complex electronic circuitry should always be illustrated with a separate schematic. Also, a figure may show a combination of actual parts and electronic symbols, such as the pill dispenser in Illustration 6.36.

Any element, including electrical components, mentioned in the description must be designated with a reference numeral using a lead line, as shown in Illustration 6.35. Customary letter-and-numeral designations for electronic parts may also be used, such as D3, R12, L3, Q23, IC5, C21, and T1. ("D" means diode, "R" means resistor, "L" means inductor, "Q" means transistor, "IC" means integrated circuit, "C" means capacitor, and "T" means transformer.) If the value of a component—such as the resistance of a resistor—is important, it should be included in the description or the drawing. Parts not mentioned in the description need not be designated with reference numbers, but they may be labeled with values in the drawing. A subcircuit, such as that indicated by reference numeral 260 in Illustration 6.35, may be enclosed by a box in dashed line. If an electrical connection or line is mentioned in the description, it must also be designated with a reference numeral, for example, "input line 125 of A/D converter 230…." The line terminations—whether inputs or outputs—may be labeled, such as in Illustration 6.35. If a circuit is too large to fit on one sheet, it may be extended across several sheets. (See above, on partial views, for details.) Although electronic schematics are used in these illustrations, the same rules and principles also apply to other types of schematics.

Block Diagrams

An electronic circuit may be represented by a block diagram, such as in Illustration 6.37, instead of a detailed schematic, if the blocks represent conventional circuits. (If any block repeats a nonconventional circuit, the details of the current should be drawn on a separate figure and explained in the specification.) Generally, block diagrams are used to show very complex circuitry that would otherwise require huge schematics. The blocks must be designated with reference numerals and lead lines and should be labeled with short names or descriptions positioned within the blocks. The lines connecting the blocks must be designated with reference numerals if they are specifically mentioned in the description, although it is not usually necessary to mention the lines. If the lines are not specifically mentioned, they do not have to be designated with reference numerals. Note the arrows on the interconnection lines to show the direction of signal flow. A block diagram too large for one sheet may be spread across several sheets. (See above, on partial views, for details.)

Note that whenever a labeled block is used to represent a component, including a circuit, the component represented by the block must be already known to a PHOSITA (person having ordinary skill in the art); otherwise the patent application must specifically show and describe the component.

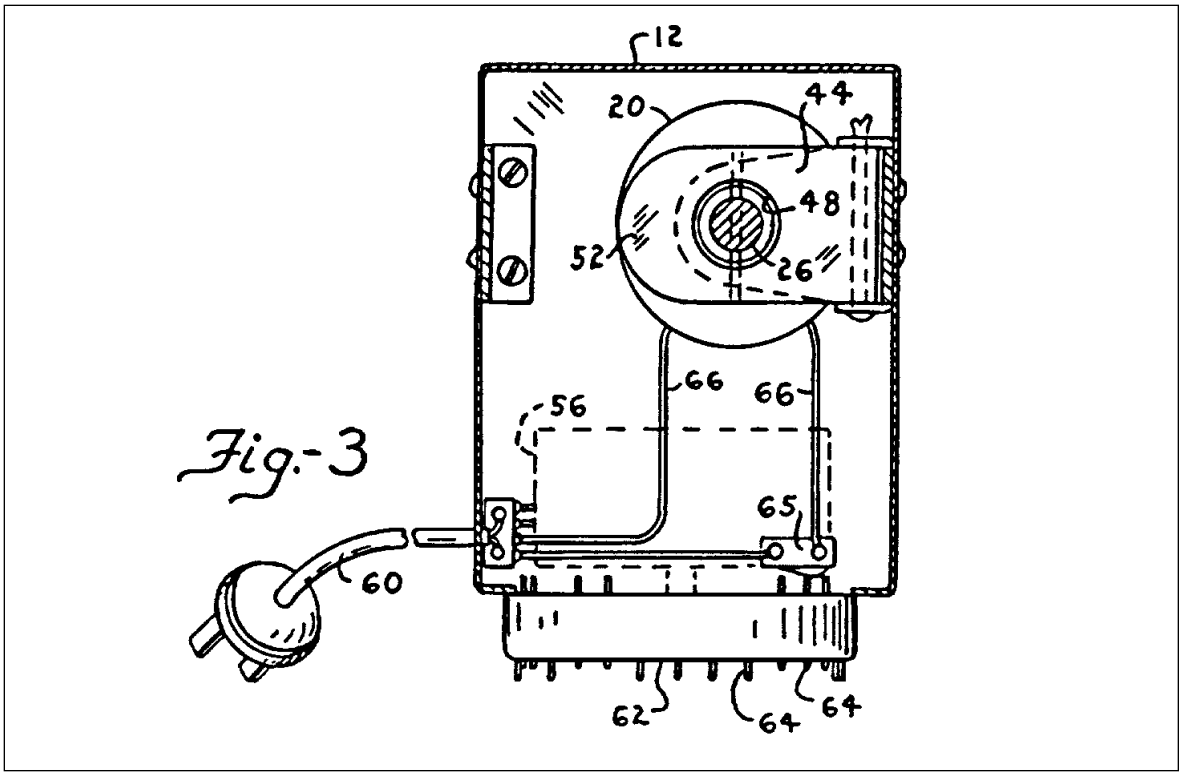


Illustration 6.34—Electrical Circuit Drawn as Actual Parts

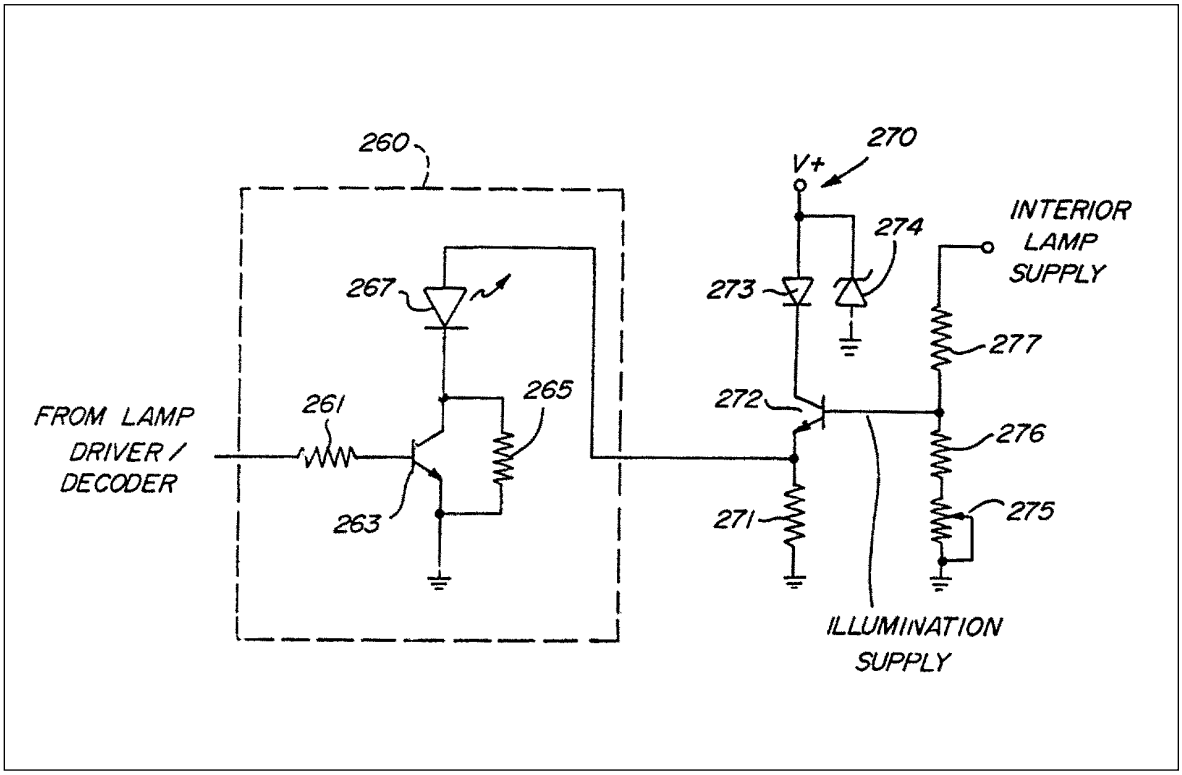


Illustration 6.35—Electronic Schematic

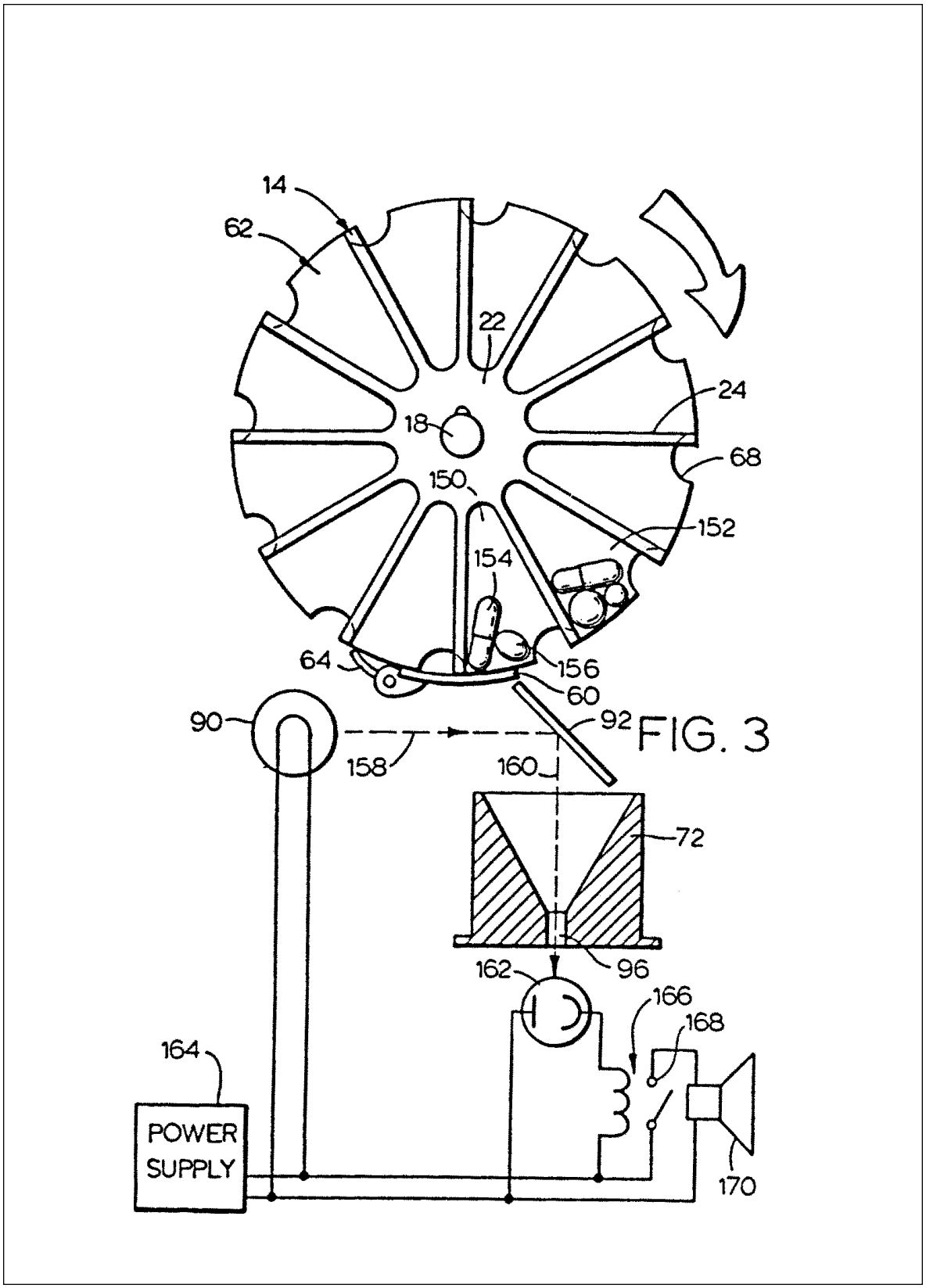


Illustration 6.36—Actual Parts Combined With Symbols

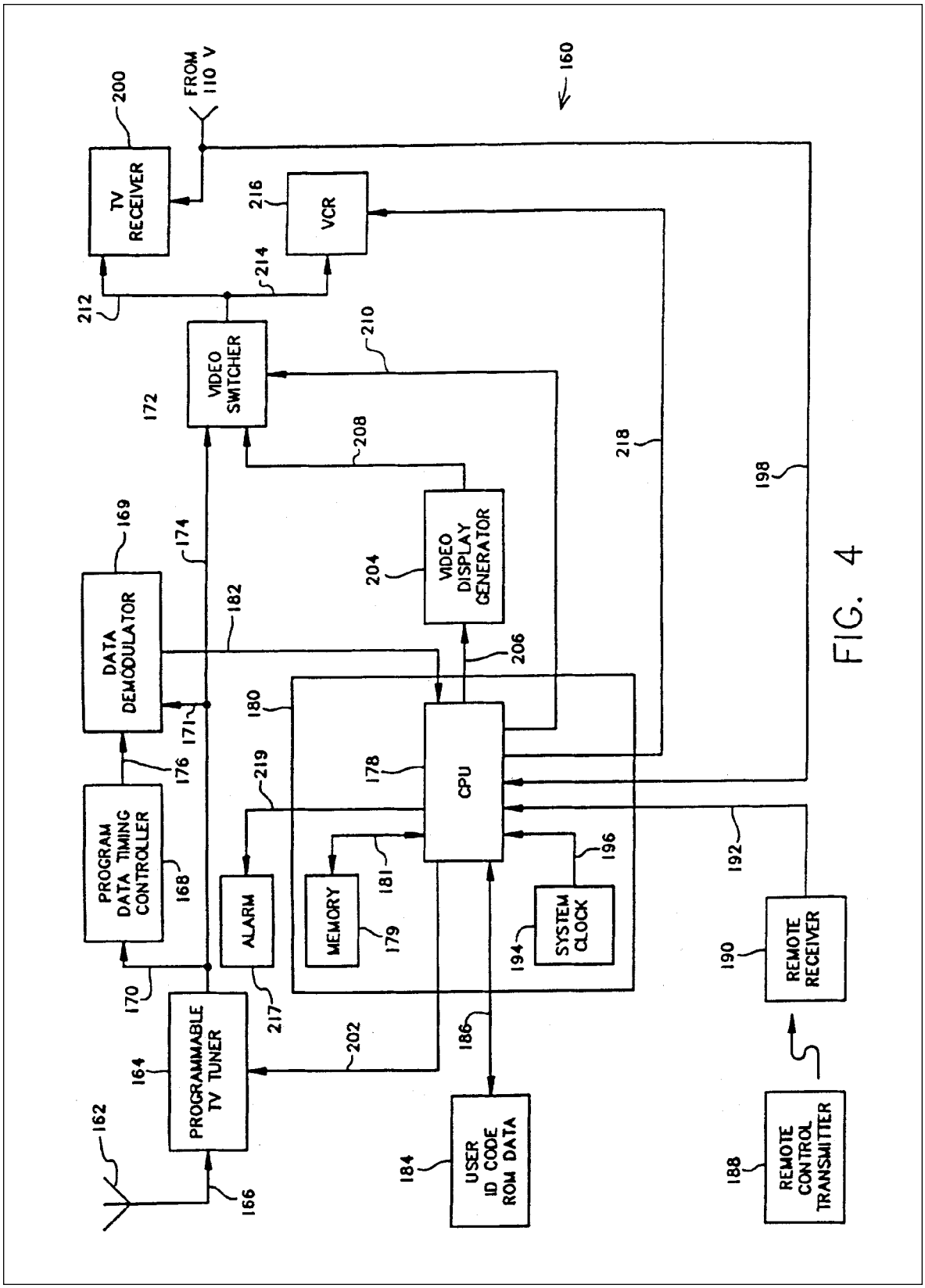


FIG. 4

Illustration 6.37—Block Diagram

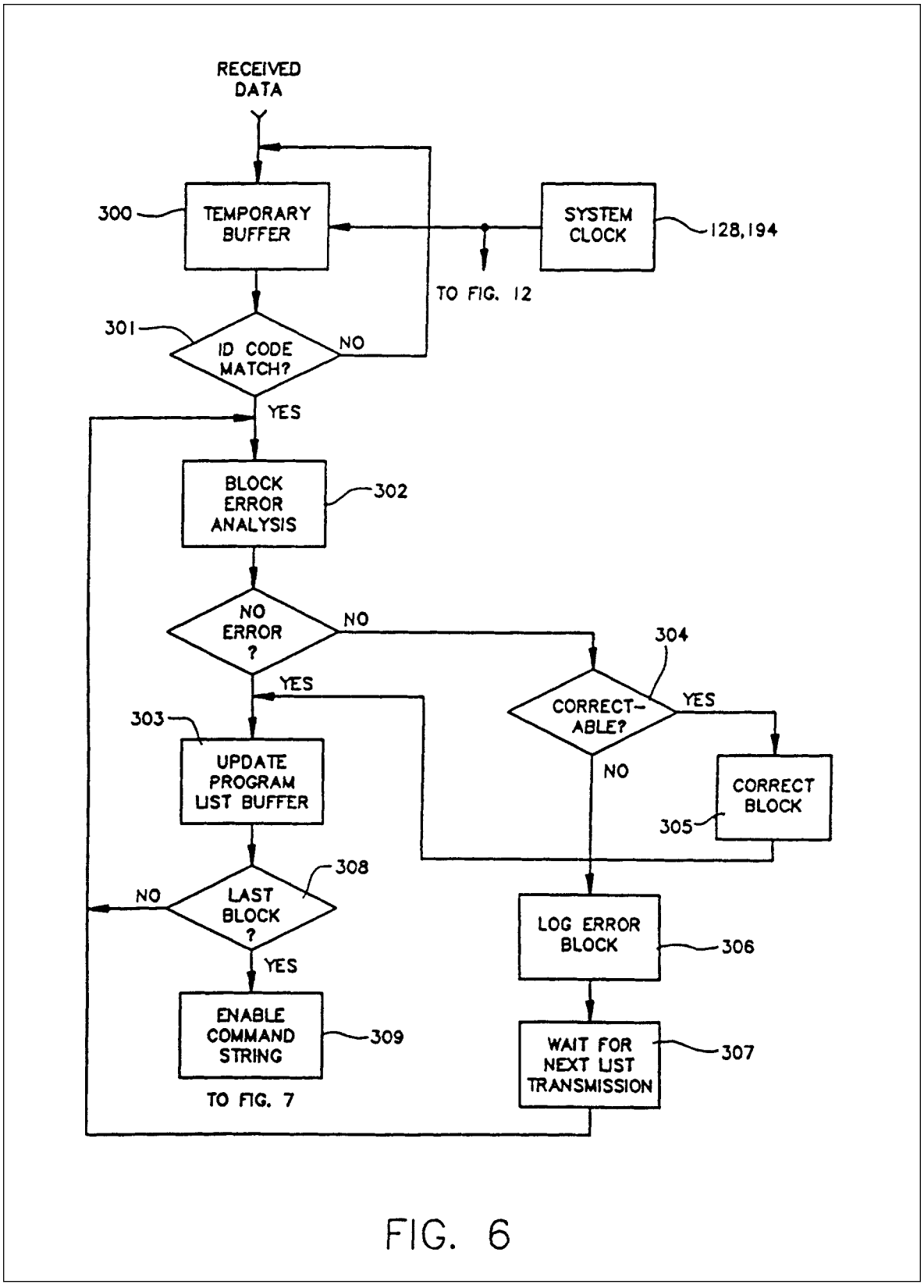


FIG. 6

Illustration 6.38—Software Flowchart

FIG. 4a

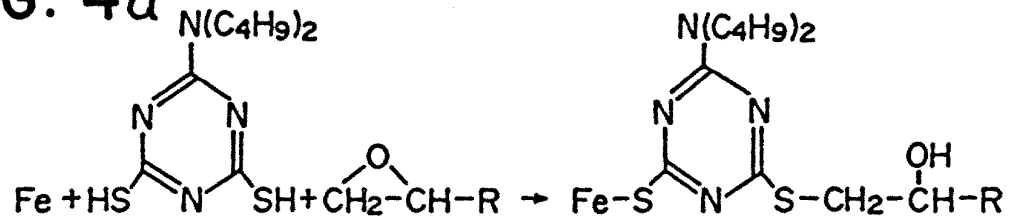


FIG. 4b

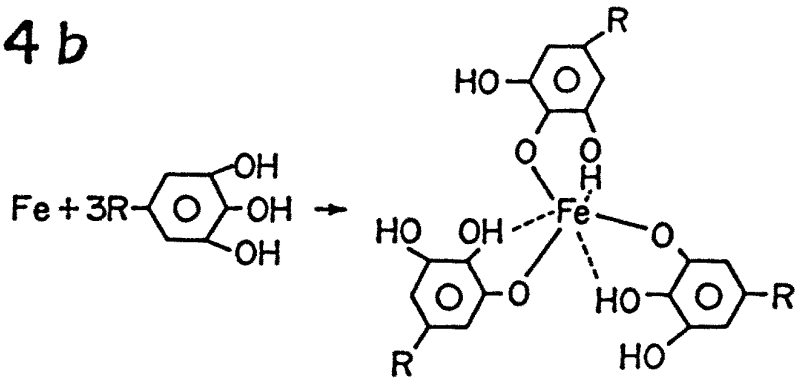
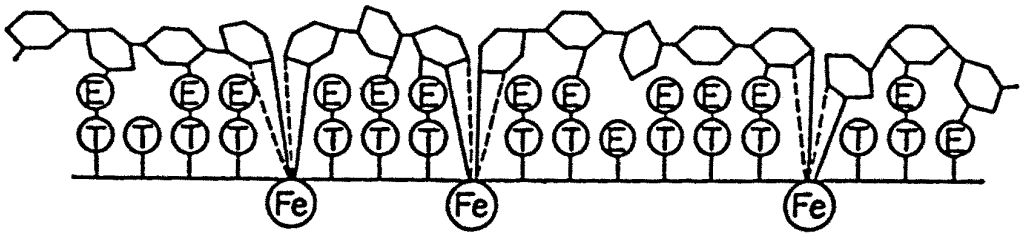


FIG. 4c



T: Triazine dithiol
E: Epoxy compound

Illustration 6.39—Chemical Formulas

Flowcharts

Processes such as manufacturing methods and computer programs are typically illustrated with flowcharts. The shapes of the boxes used in computer flowcharts should conform to standard practice: rounded box = connector; rectangles = process; diamond = decision; parallelogram = input/output; and so on. A typical software flowchart is shown in Illustration 6.38, and includes boxes connected by arrows. Each box includes a short description. All the boxes should be designated with reference numerals and lead lines. Again, if a flowchart is too large for a single sheet, it may be spread across several sheets. (See above, on partial views for details.)

Formulas and Tables

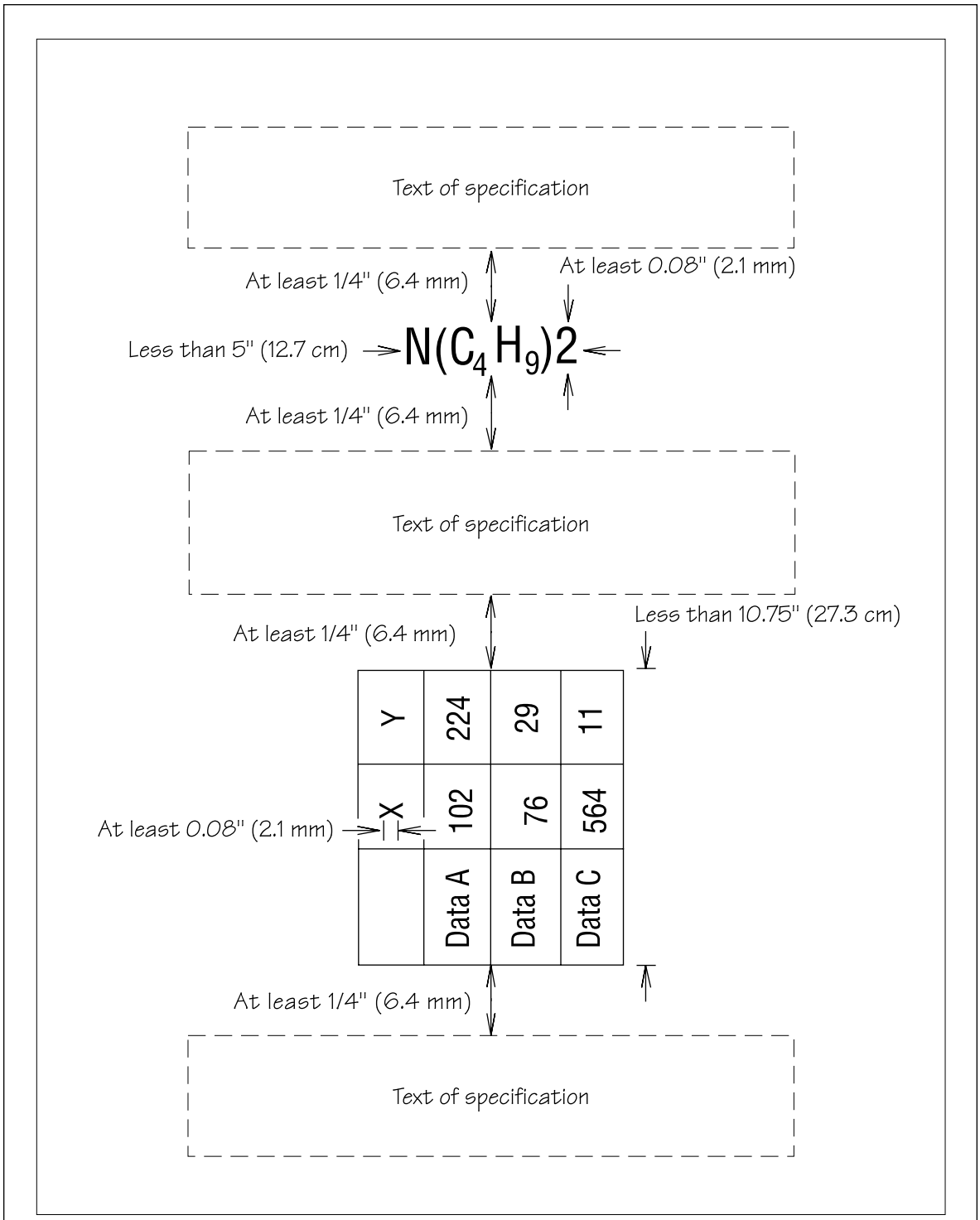
Chemical formulas, mathematical formulas, and tables are substantially textual information, so they may either be submitted as drawings or incorporated into the description. Tables and formulas may be included in the claims (legal description).

If presented as drawings, each formula and table must be labeled as a separate figure. Technically, the individual symbols and characters in a formula are not connected. However, no bracket, such as that required for exploded views, is usually required. If a formula is so complex that it may be confused as separate figures, then a bracket must be used. Typical chemical

FIG. 7

OVERALL GEAR RATIO	MAIN GEAR UNIT GEAR RATIO	AUXILIARY GEAR UNIT RATIO
FIRST	FIRST	REDUCTION
SECOND	SECOND	REDUCTION
THIRD	THIRD	REDUCTION
FOURTH	THIRD	DIRECT
FIFTH	FOURTH	DIRECT

Illustration 6.40—A Typical Table



A formula or table less than 5" (12.7 cm) wide should be positioned horizontally, and a formula or table more than 5" wide but less than 10.75" (27.3 cm) wide should be positioned vertically.

Illustration 6.41—Formulas and Tables in Specifications

formulas are shown in Illustration 6.39, and a typical table is shown in Illustration 6.40.

If incorporated into the specification, characters used in formulas and tables must be of a block (nonscript) type font or lettering style, as shown in Illustration 6.41. Capital letters must be at least 0.08" or 2.1 mm high (about 10 points), although smaller lower caps may be used. A space of at least 0.25" or 6.4 mm should be provided between complex formulas and tables and the text of the description. Lines and columns of data in tables should be closely positioned to conserve space. The width of a formula or table should be limited to 5" or 12.7 cm, so that it may appear within a single column in the printed patent. If it is not possible to limit the width of a formula or table to such size, it may be placed vertically, and have a maximum height of 10.75" or 27.3 cm.

Waveforms and Plots

Electrical waveforms and plots of other numerical relationships must be presented as drawings. A group of waveforms that illustrates events related in time must be presented as a single figure with a common vertical axis and extend in a horizontal direction, as shown in Illustration 6.42. The horizontal direction represents time, so therefore the waveforms must be drawn to the same scale, so that signals that occur simultaneously line up properly. Alternatively, waveforms may be presented as separate figures, as shown in Illustration 6.43. Electrical waveforms, whether presented as a single or separate figures, may be connected with optional dashed lines to show relative timing relationships between them. This is the only exception to the rule that prohibits separate figures from being connected. (See Chapter 8 for details on drawing rules.)

Each waveform must be designated with reference letters or descriptive text. The designation of each waveform may be placed anywhere next to the vertical axis, such as to the left in Illustrations 6.42 through 6.44. Different portions of interest in each waveform may be designated with reference numerals, such as in Illustration 6.44, and/or labeled with descriptive text, such as in Illustrations 6.42 through 6.44.

Short waveforms may (and should) be presented in electronic schematics. For example, a cycle of a sine wave can be provided adjacent to the input of a rectifier and a DC pulse can be provided adjacent to the output.

Typical plots are shown in Illustration 6.45. Each plot must be shown as a separate figure and provided with a descriptive label.

Nonstandard Symbols

Standard symbols should be used whenever possible, but nonstandard symbols may be used if they are not likely to be confused with standard symbols. Nonstandard symbols are subject to the approval of the PTO. If you are unfamiliar with standard symbology for the field of your invention, and your invention is a very simple device, you can probably use nonstandard symbols. For example, a widget with just a few electronic parts connected in a simple way can be illustrated by drawing the actual parts, or labeled rectangles to represent the parts, such as in Illustration 6.46. However, this technique cannot be used for anything but extremely simple devices, because much of the information conveyed by standard symbols cannot be conveyed by labeled rectangles.

Character Size

Any numeral or letter used with graphical symbols in drawings, including lowercase letters in the labels, must meet the size requirement for reference characters, which is a minimum of ⅛" or 3.2 mm high (about 12 points; see Chapter 8 for details on character size requirements).

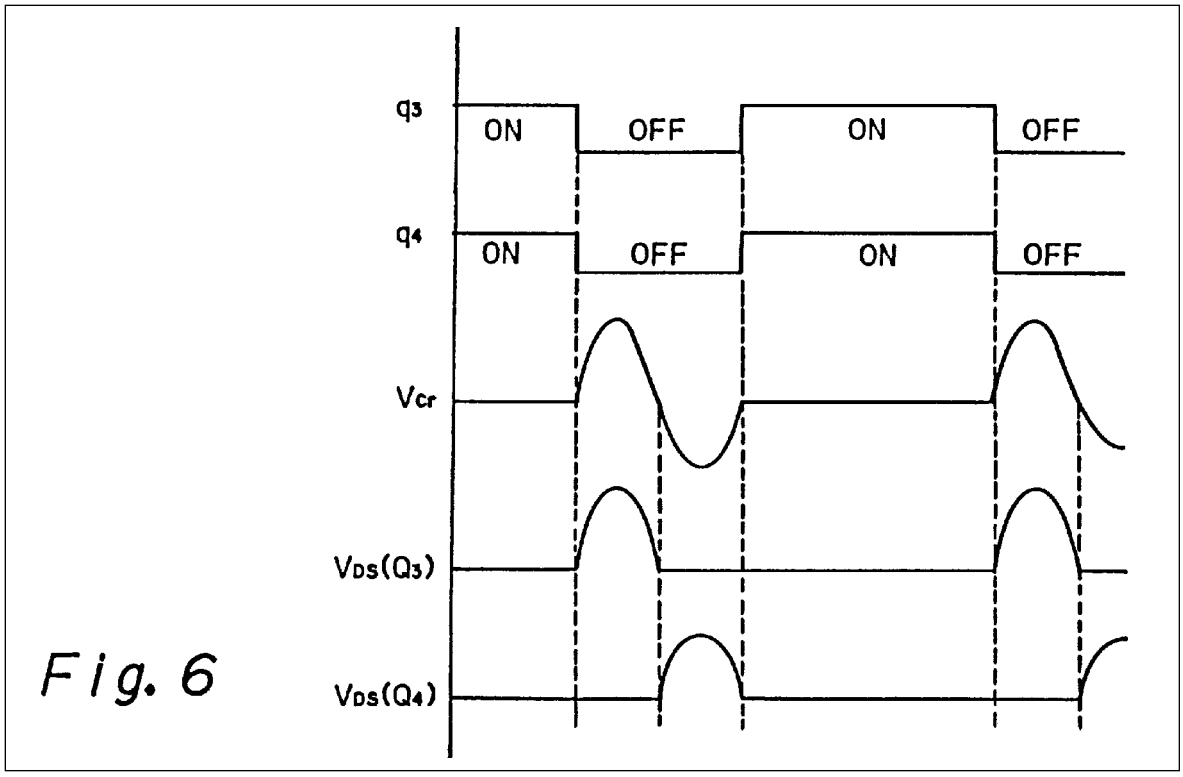


Illustration 6.42—Waveforms in Single Figure

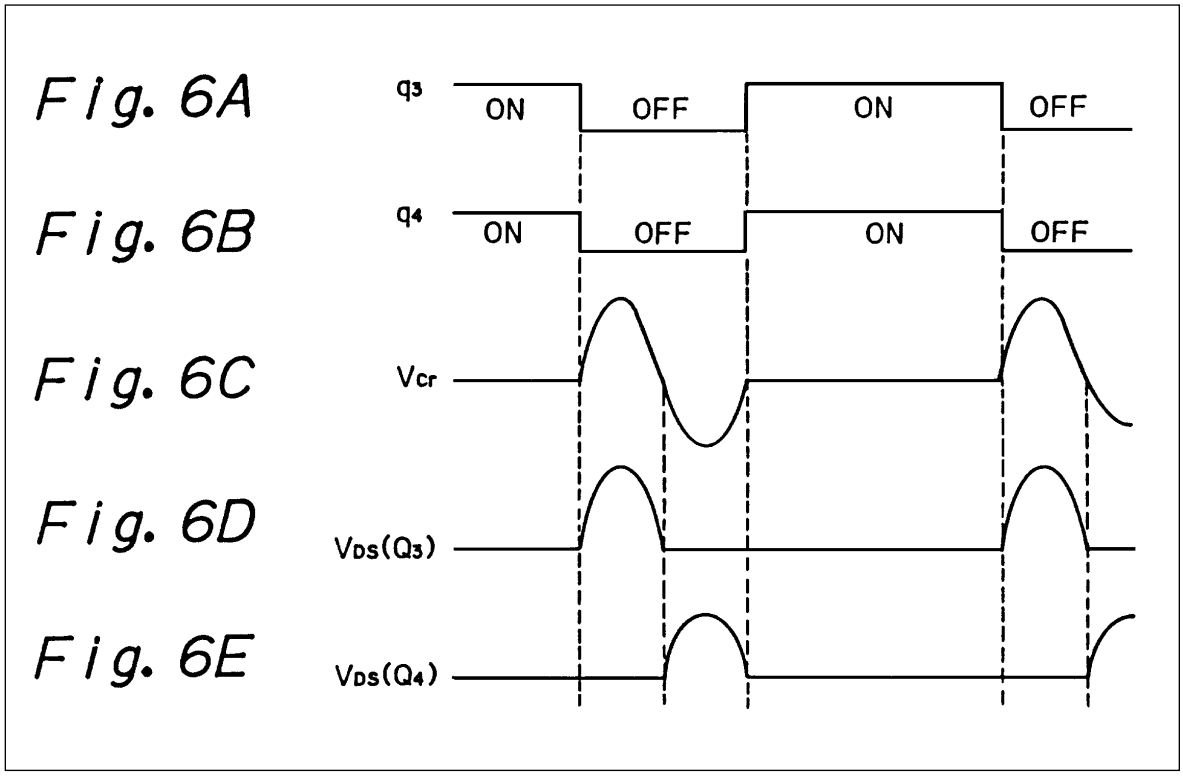


Illustration 6.43—Waveforms in Separate Figures

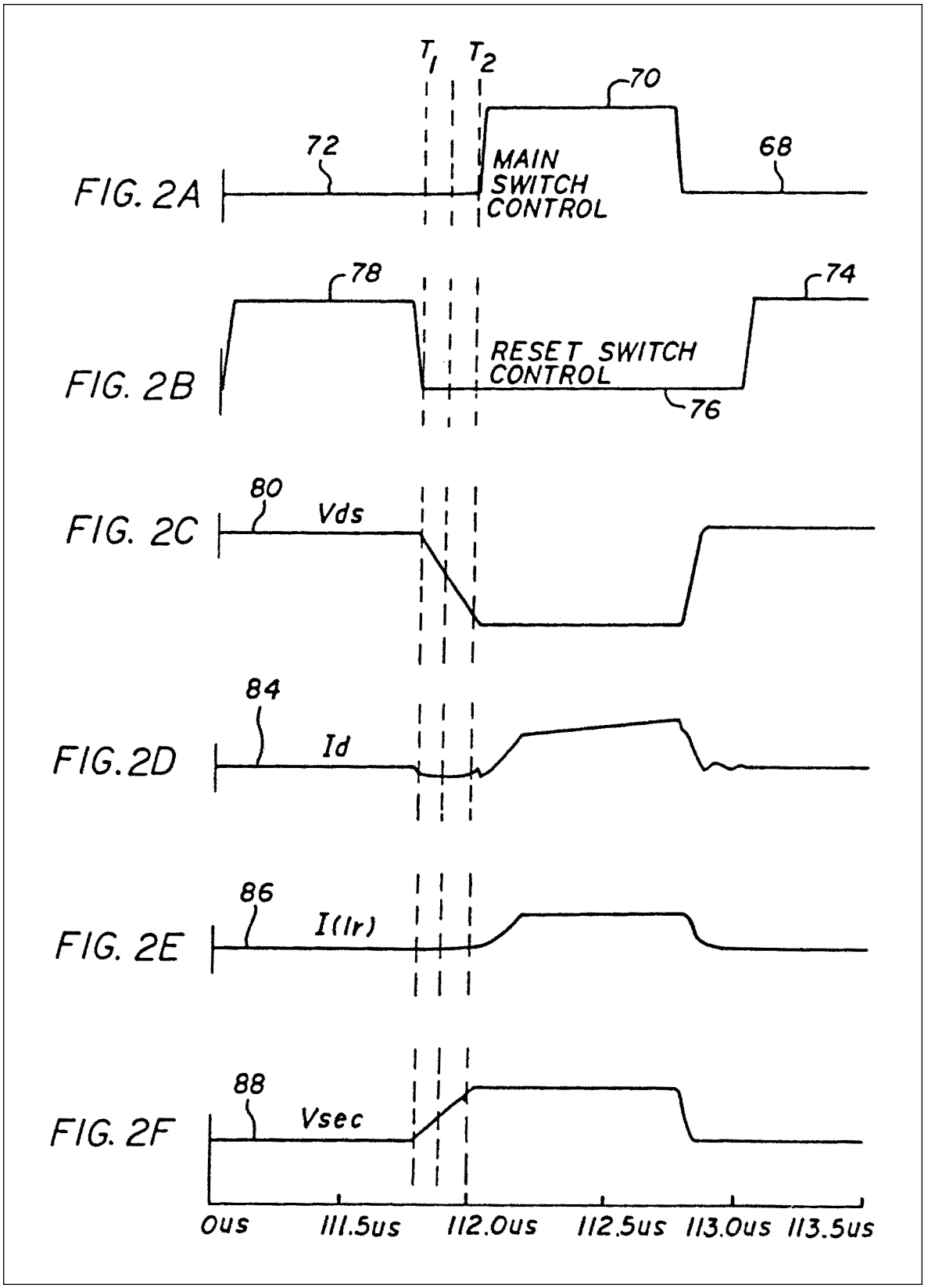


Illustration 6.44—Numerals Designating Points of Interest

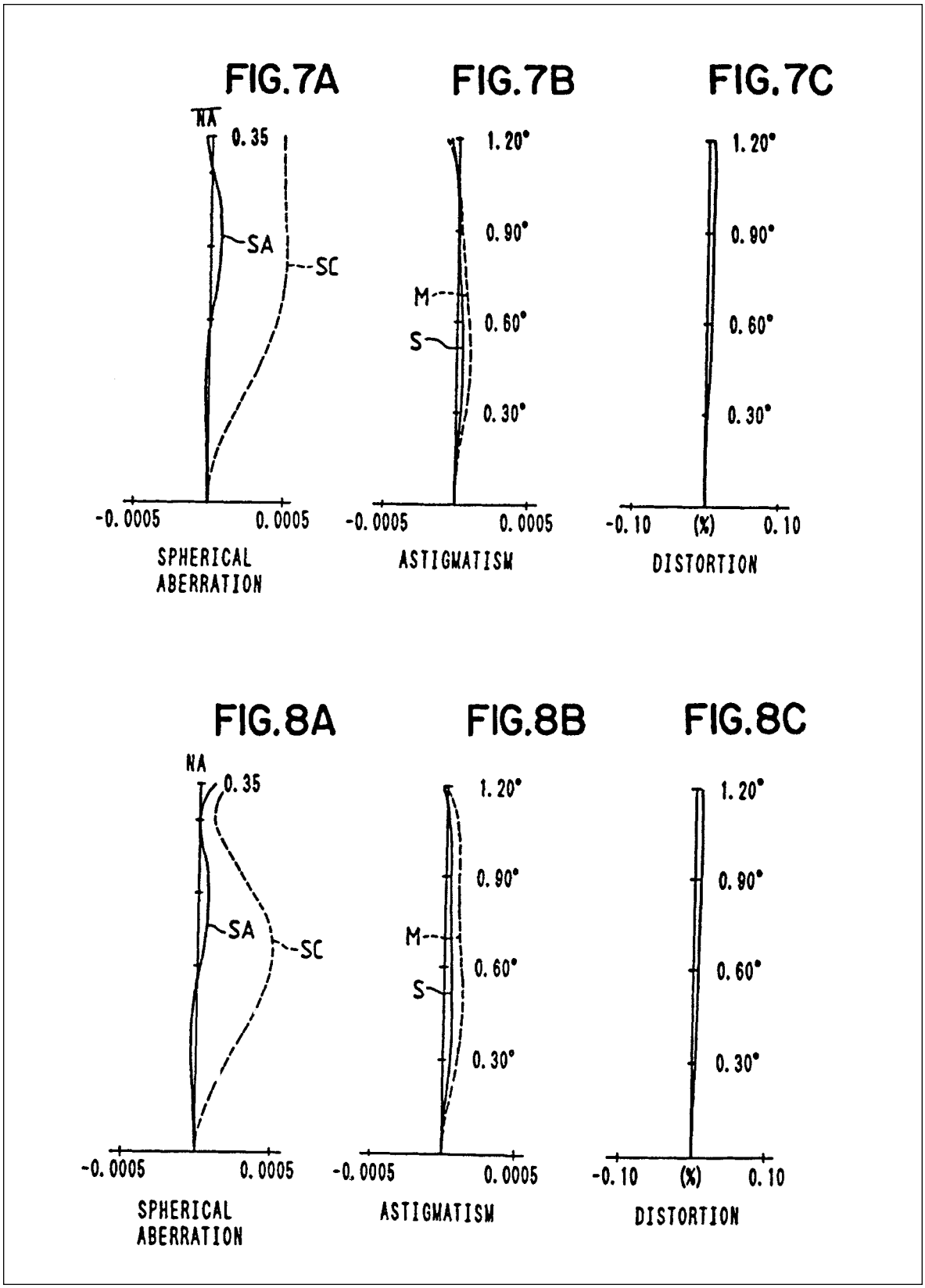


Illustration 6.45—Plots

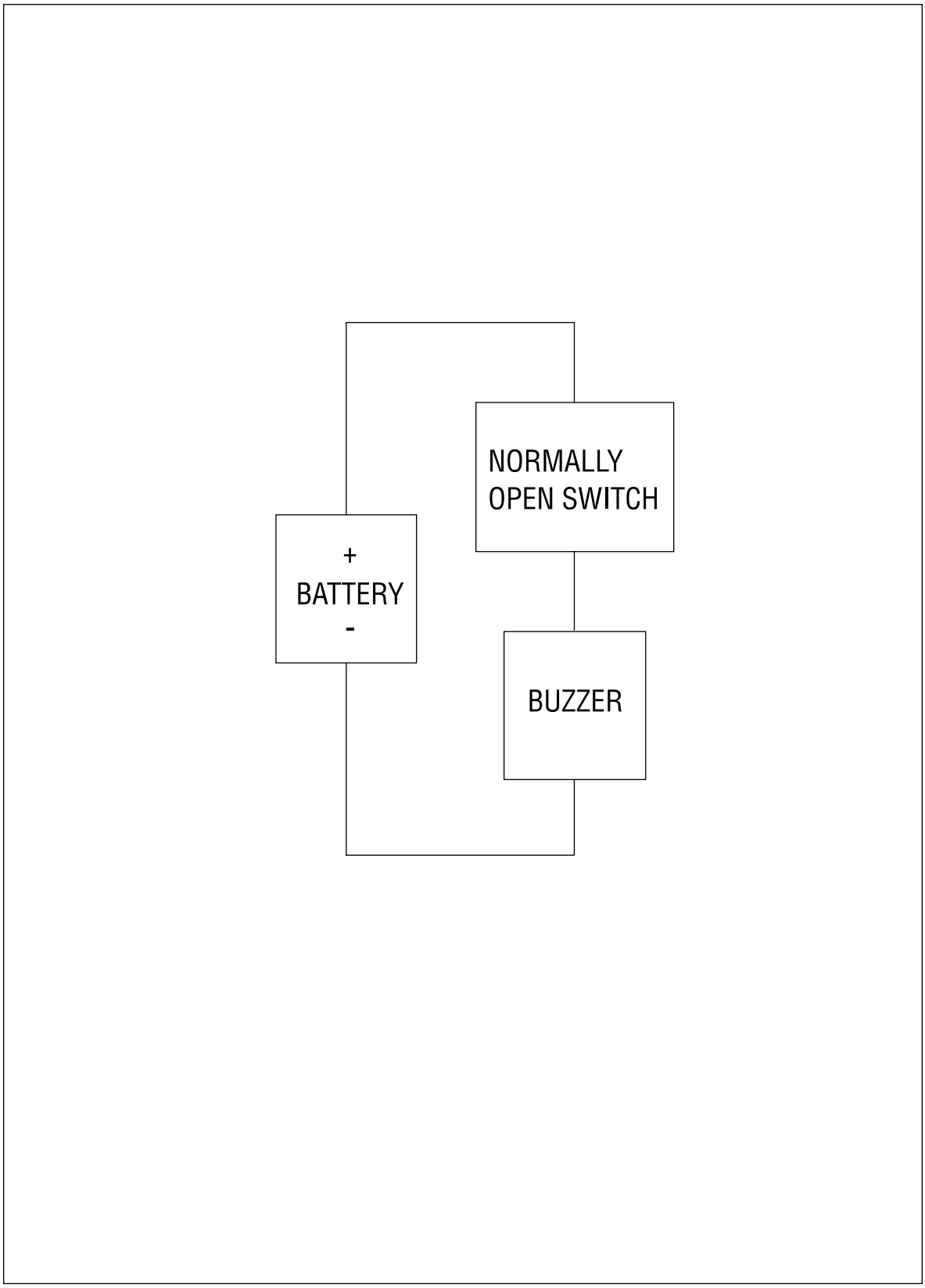


Illustration 6.46—Nonstandard Symbols

It is best to use all caps, because if a mix of upper- and lowercase letters is used, and the lowercase letters are 3.2 mm high, the caps will be too large. An exception to the size rule allows superscripts (for example, the "3" in 2^3) and subscripts (for example, the "2" in H_20) to be smaller than 3.2 mm.

Descriptive Text

Descriptive text is usually not allowed in patent drawings, except in blocks such as block diagrams, flowcharts, and tables. However, descriptive text should be used, and may be required, where the part is unusual or the figure is not easily understandable.

Multiple Embodiments

Multiple embodiments (versions) of an invention may be included in a patent application. The different embodiments must be presented as separate figures. For example, if one embodiment of a telephone has a particular handset, and you wish to show an alternative handset, you cannot show it in the same figure as the first handset, even if you use dashed lines. The alternative handset must be shown in a separate figure, although the rest of the telephone does not have to be shown again.

We recommend using a common figure number with distinguishing letter suffixes for each embodiment. For example:

Embodiment 1:

Fig. 1A (front view)

Fig. 1B (side view)

etc. (See Illustration 6.47.)

Embodiment 2:

Fig. 2A (front view)

Fig. 2B (side view)

etc. (See Illustration 6.48.)

If an examiner determines that the claimed embodiments are sufficiently different, he or she will require you to restrict the application to a single invention—that is, to elect (choose) the claims to one embodiment and cancel the claims that show the other embodiment. You may argue that the variations are not great enough to warrant treating the embodiments as separate inventions, or you may accept the requirement. If you accept the requirement, you may either file a divisional (separate) application for the canceled embodiment, or drop it. (See "divisional applications" in *Patent It Yourself,* Chapter 14, for details.)

Line Types and Width

Typical line types and widths for utility patent drawings are shown in Illustration 6.49:

- Edge lines (lines that represent edges and corners of an object) should be continuous lines about 0.2 mm thick.
- Hidden lines (lines that represent parts or edges that are hidden behind other parts) should be dashed lines about 0.2 mm thick. Hidden parts should be shown only when necessary so as to avoid cluttering the figure.
- Phantom lines (lines that represent components that are not part of an invention, or a moved position of a component that is part of the invention) should be dot-dot-dash lines about 0.2 mm thick. Components that are not part of the invention may also be shown in continuous lines, which are actually preferable because they are clearer.
- Shading lines (lines that represent shadows or surface contour) should be continuous or irregularly broken lines about 0.1 mm thick. Their thinness distinguishes them from edge lines to avoid confusion.

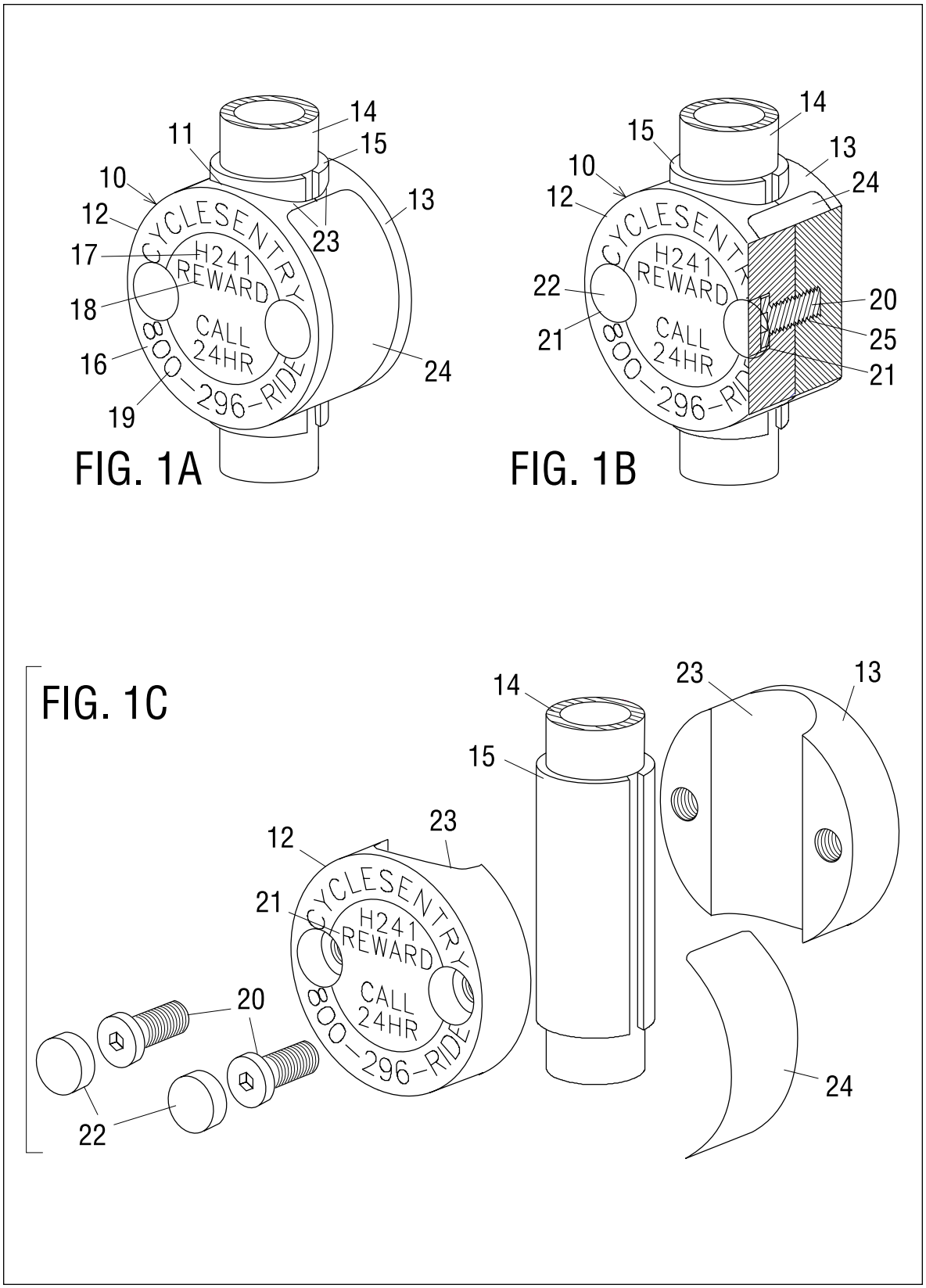


Illustration 6.47—Distinguishing Multiple Embodiments

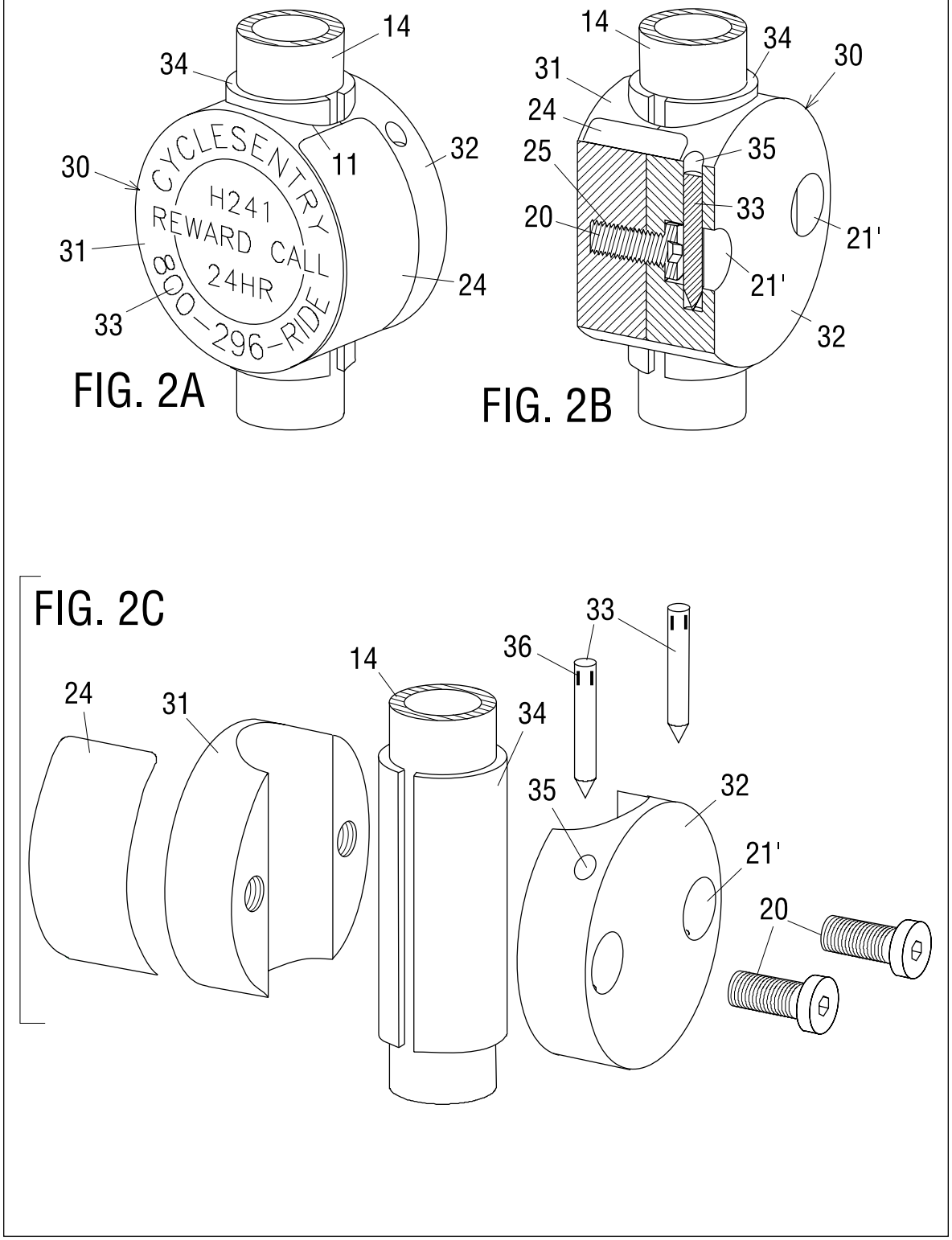
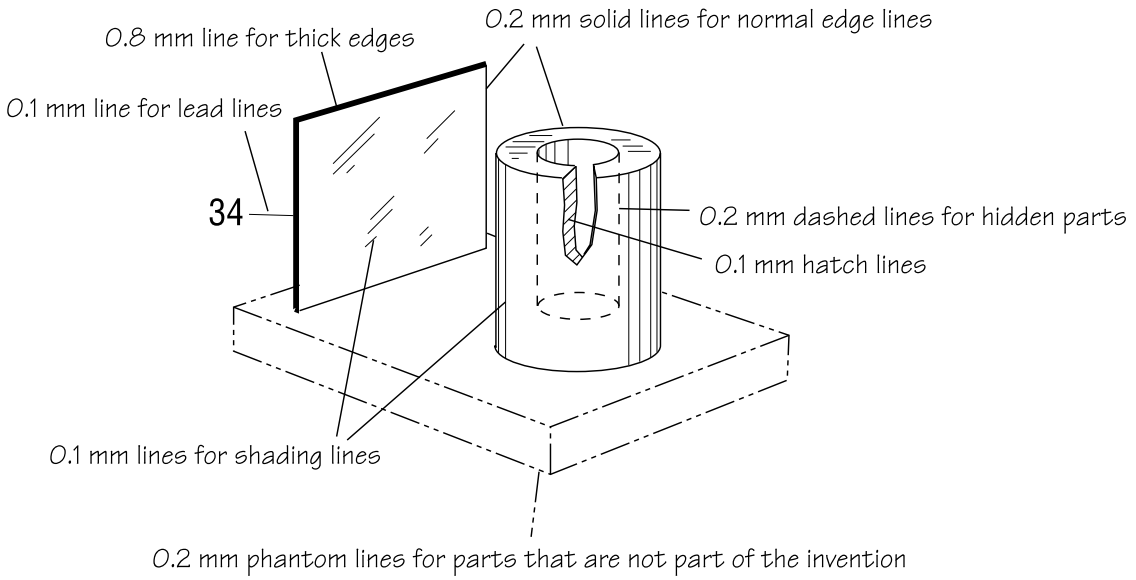


Illustration 6.48—Distinguishing Multiple Embodiments



Note that lead lines for hidden or phantom parts are drawn with corresponding line types.

Illustration 6.49—Line Types and Widths

- Thick edge lines (lines representing thick sheets or cords) should be about 0.5 to 0.8 mm thick.
- Hatch lines (oblique parallel lines that represent sectioned parts) must be continuous lines, and should be about 0.1 mm thick. Their thinness distinguishes them from edge lines to avoid confusion.
- Lead lines should be no more than 0.1 to 0.2 mm thick. A lead line may optionally be of a type that corresponds to the part it is touching, for example, a continue lead line for a part in continuous lines, a dashed lead line for a part in dashed line, and so on.

Some Additional Points to Keep in Mind

In addition to the guidelines discussed above, here are some other pointers.

Not too thick. Edge, hidden, and phantom lines should not be much thicker than 0.2 mm, because thicker lines tend to obscure small details. For example, if the lines are made too thick, the gap between two closely spaced parallel lines would get too small or even disappear.

When thicker is okay. In a sectional view, edge lines may be about 0.3 mm thick, instead of the normal 0.2 mm, to more clearly distinguish them from the 0.1 mm hatch lines. Cords, cables, thick edges of sheets, or anything that is too thick to be represented by 0.2 mm lines, but not thick enough to be represented by a pair of parallel lines, may be represented by a single thick line of about 0.5 to 0.8 mm.

Graphical symbols. Graphical symbols—including schematics, flowcharts, and waveforms—should be made with continuous or dashed lines as necessary and be about 0.2 to 0.3 mm thick.